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ROLE AND IMPORTANCE OF PRINT DENSITY IN CONTINUOUS INKJET (CIJ) & DROP-ON-DEMAND (PIJ) INKJET PRINT ENGINES AND IDENTIFICATION OF VARIOUS FACTORS TO OPTIMIZE INK DENSITY

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ABSTRACT

Inkjet printing is the printing technology in which droplet of ink is bombarded onto the substrate to print. It is available in two major forms; Continuous Inkjet and Drop-on-Demand. At one hand, in continuous inkjet printing system ink is expelled continuously in the form of dots to reach to the desired print locations using deflection system, on the other in the drop-on-demand (Piezoelectric) ink is expelled from the ink reservoir with the help of piezoelectric crystal, as per the demand of print areas. Objective of this paper is to compare and optimize the ink density in Continuous Inkjet and Drop-on-Demand (Piezoelectric) print engines. A master test chart was prepared with the help of Pressign colour control bar solid C, M, Y, K tint patches and was printed with the help of CIJ and DOD-PIJ presses in the standard pressroom conditions. The printed sheets were tested on solid CMYK patches with the help of X-rite Exact Spectro-densitometer. The solid ink density results were compared and various ways for density optimization are suggested in the paper.

KEYWORDS: - Continuous Inkjet, Drop-on-Demand (Piezoelectric), Inkjet Print Engines, Ink Density, Tint Patches

INTRODUCTION

Digital printing has become popular now days because of short run compatibility and personalization benefits it can impart. Inkjet printing is the form of digital printing in which ink droplets are used to print with the help of suitable programming. Inkjet is quite new printing method which is penetrating the print market and it is coming up with good print quality and speed [1]. Recent inkjet technologies are speed oriented and there is strong requirement to cure rapidly to support speedy production [2]. Inkjet is said to be the future of digital printing and it may replace the web offset for packaging and publication segment in the coming time [3,4]. In the continuous inkjet (CIJ), the ink is expelled continuously from the ink reservoir and with the help of a deflection system ink is reached to the image areas. The excessive ink is returned back to the reservoir. Drop-on-demand (Piezoelectric-PIJ) form of inkjet printing utilizes the drops of ink in the areas only where drop is required. It is done with the help of piezoelectric crystal which swells and shrinks with the help of electric charge [5,6,7].

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RESEARCH OBJECTIVES

With the increased customer expectations time has come when the digital printers need to be more quality conscious. The print quality is not only a result of the properties of the paper but also of the dynamic interactions between paper and ink during the printing process. To improve runnability and printability the demands of papers ability to rapidly absorb the oils/solvent and make the colorants stay on the surface is increased for achieving Solid Ink Density targets on the surface. Requirements for SID have grown among the printers more as the technology develops and the print speed significantly increases.

Solid ink density is an important print quality parameter which represents colour darkness on the 100 % areas of CMY&K on the prints. Other quality parameters i. e. dot gain, print contrast, hue-error, trapping etc. are dependent on it and controlling ink density is the need of the hour for every quality conscious printer. This paper focuses on comparing the Solid Ink Density in Continuous Inkjet and Drop-on-Demand (Piezoelectric) Inkjet Print Engines on coated (gloss and matte) and uncoated paper stocks. Further, various ways to optimize the density will be suggested in the paper.

RESEARCH METHODOLOGY

From the local market different varieties of papers were explored. The papers best matchable to ISO specifications were taken into consideration. GSM 130 was selected. Three varieties of papers namely uncoated, matte coated and gloss coated was taken into consideration to check their SID behavior on CIJ and PIJ forms of Inkjet.

A master test chart was prepared in Corel Draw Graphics Suite 2020 with the help of various tint patches. The SID patches were created with the help of colour control strip produced by Pressign. The printing work was carried out on Canon VarioPrint i-seris, Codak Prosper 6000 names given DOD, and CIJ presses respectively.

The prints were taken in standard pressroom conditions. 500 sheets of various papers were printed and for testing purpose sheets were extracted each sheet after 20 sheets for each paper. SID can be measured objectively by physical measurements using instruments. Ink density was measured with the help of X-Rite (Exact) Spectro-densitometer available in the Quality Control Laboratory, Department of Printing Technology, GJUS&T, Hisar. The Cofomegra standard solid ink density values were taken as reference for the measurement, shown in the table below.

Table.1. Cofomegra standard SID reference values

	C	M	Y	K
Uncoated Paper	1.20+/-.05	1.15+/-.05	1.10+/-.05	1.60+/-.10
Matte Coated Paper	1.35+/-.05	1.30+/-.05	1.25+/-.05	1.75+/-.10
Gloss Coated Paper	1.45+/-.05	1.40+/-.05	1.35+/-.05	1.80+/-.10

DATA COLLECTION & ANALYSIS

The solid ink density was measured on 20 printed seats extracted after specific interval and further average was taken. Cofomegra SID values were taken as reference values. The average density measured values on uncoated paper, matte coated paper and gloss coated paper are shown in table 2 to table 4 respectively given below: -

Table.2. Average SID values on Uncoated Paper Stock on CIJ and DoD (PIJ) Presses

Solid Ink Density	C	M	Y	K
CIJ	1.01	0.97	0.92	1.32
DoD (PIJ)	1.06	1.01	0.97	1.38

From Table.2. and Chart.1. it is quite evident that Solid Ink Density of Piezoelectric was found more compared to the DOD-PIJ on uncoated paper stocks. The possible reason is the controlled uniform supply of inks in PIJ presses which penetrate more into the uncoated paper stocks with high resolution resulting into high ink hold out and hence more solid ink density is found in case of DOD-PIJ presses.

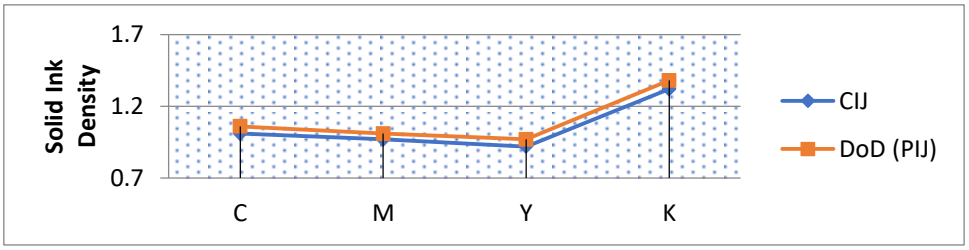

Chart.1. Average SID values on uncoated paper stocks

From the Table.3., it is found that Solid Ink Density of Continuous Inkjet was found less compared to the DOD-PIJ form of the Inkjet on mate paper stocks. The reason is the inks of the PIJ presses which could not penetrates more into the matte coated paper stocks resulting into more ink hold out and hence more density is found in case of DOD.

Table.3. Average SID values on Matte Coated Paper Stock on CIJ and DoD (PIJ) Presses

Solid Ink Density	C	M	Y	K
CIJ	1.14	1.1	1.05	1.5
DoD (PIJ)	1.2	1.15	1.1	1.57

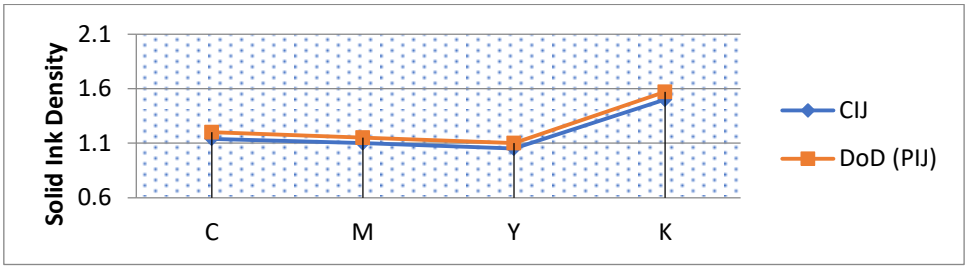

Chart.2. Average SID values on matte coated paper stocks

Table.4. Average SID values on Gloss Coated Paper Stocks on CIJ and DoD (PIJ) Presses

Solid Ink Density	C	M	Y	K
CIJ	1.23	1.19	1.14	1.5
DoD (PIJ)	1.29	1.24	1.2	1.56

From the Table.4., Chart.3. it is evitable that Solid Ink Density of PIJ inkjet was found more compared to the CIJ form of the Inkjet on gloss coated paper stocks. The reason might be the inks of the PIJ presses which could not penetrates more into the gloss coated paper stocks resulting into more ink hold out and hence more density is found in case of DOD-PIJ.

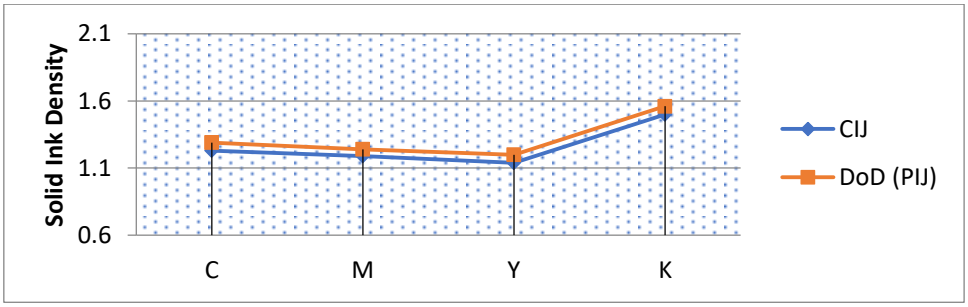

Chart.3. Average SID values on gloss coated paper stocks

RESULTS AND DISCUSSION

Solid ink density values in Continuous Inkjet Presses were found 12-15% lower than the standard Cofomegra reference values. The possible reason for the lower values is the bombarding of low viscosity inks on the paper substrate which penetrates the surface structure of the paper. In Drop-on-demand (PIJ) presses, the SID values were found only 6-8% lower than the reference Cofomegra values. It is due to low penetration of PIJ inks on the paper substrates. While comparing solid ink density between continuous inkjet (CIJ) and drop on demand (DOD) piezoelectric inkjet printing presses, there are several factors to consider.

CIJ printing uses a continuous stream of ink droplets that are selectively charged and deflected by an electric field, creating a pattern on the substrate. In contrast, PIJ printing uses piezoelectric crystals that expand and contract to create pressure pulses that eject droplets of ink from a print head nozzle.

PIJ inkjet printing exhibited higher solid ink density compared to CIJ printing. This is because PIJ printing allows for more precise control over the amount and placement of ink droplets, which can result in a higher ink film thickness and more uniform ink distribution. Additionally, DOD-PIJ print heads can generate smaller droplets with high viscosity than CIJ print heads, which can further increase solid ink density.

However, it's important to note that the specific solid ink density achievable with either printing technology will depend on various factors such as ink formulation, substrate properties, printing resolution, and printing speed. Further, solid ink density is found better in

both the types of presses on coated paper stocks than uncoated paper due to its better surface finish and less porosity.

CONCLUSION

From all above discussion it is found that SID is the function of paper type used along with the type of inkjet press. Absorbency of the paper is more in case of uncoated paper compared to the coated stocks. If the paper is more absorbent then ink hold out remains less and it further causes density loss. So, it is necessary to control the absorbency of the paper by using fillers and coating materials onto the surface of the papers. The technological advancements, modifications in inks formulation, substrate properties, printing resolution, and printing speed can help in improving the SID in both types of inkjet printing presses.

REFERENCES

1. Adams, K. (2022). Five Trends for Industrial Inkjet Printing in 2022. *Packaging Technology Today*, https://www.packagingtechtoday.com/featureds/five-trends-for-industrial-inkjet-printing-in-2022/.
2. Uddin, M.J., Hassan, J., Douroumis, D. (2022). Thermal Inkjet Printing: Prospects and Applications in the Development of Medicine. Technologies, 10, 108. https://doi.org/10.3390/technologies10050108.
3. Collins, K. (2021). Six Trends in Industrial Inkjet Printing in 2021. Ink World Magazine, https://www.inkworldmagazine.com.
4. Wickström, H.; Nyman, J.O.; Indola, M.; Sundelin, H.; Kronberg, L.; Preis, M.; Rantanen, J.; Sandler, N. (2017). Colorimetry as Quality Control Tool for Individual Inkjet-Printed Pediatric Formulations. *AAPS PharmSciTech*, 18, 293–302.
5. Gudapati, H.; Dey, M.; Ozbolat, I. (2016). A Comprehensive Review on Droplet-Based Bioprinting: Past, Present and Future. Biomaterials, 102, 20–42.
6. Gigac, J., Stankovska, M., Opálená, E., & Letko, M. (2014). The effect of base papers properties on inkjet print quality. *Wood Research*, 59(5): 717-730.
7. Wijshoff, H. (2010). The Dynamics of the Piezo Inkjet Printhead Operation. *Phys. Rep.*, 491, 77–177.
8. Oittinen, P., AL-Rubaiey, H., Sipi, K. and Vikman, K. (2001). Research on Paper-Ink-Process Interactions in Electro-photographic and Ink Jet Printing. *Graphic Arts in Finland*, 30 (2), pp. 5-10.
9. Gans, B., Paul, C., & Ulrich S. S. (2004). Inkjet Printing of Polymers: State of the Art and Future Developments. *WILEY-VCH, Verlag GmbH, D-69469, Weinheim*, pp. 203-213..
10. Mei, J., Lovell, M., Mickle, M., & Heston, S. (2004). Continuous ink-jet printing electronic components using novel conductive inks, *University of Pittsburgh*, pp. 334-345.
11. Svanholm, E. (2007). Printability and Ink-Coating Interactions in Inkjet Printing. *Dissertation, Karlstad University Studies*, pp. 1-81.