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OPTIMIZATION OF PRINT CONTRAST OF UV LED INK ON CHROMO AND PE WHITE SUBSTRATES IN FLEXOGRAPHIC PRINTING PROCESS

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Abstract

Flexographic printing is widely used in the packaging and label industry due to its high speed, cost-effectiveness and ability to print on a wide range of substrates. The quality of the printed output is significantly influenced by substrate properties, which directly affect ink transfer, dot reproduction and overall print performance. This study focuses on evaluating print contrast on two commonly used substrates Chromo and PE White using UV LED flexographic printing.

The print contrast test was carried out to analyze the sharpness, tonal reproduction and overall print quality of the Cyan, Magenta, Yellow and Black (CMYK) process colors printed on both substrates. Standard printing conditions were maintained throughout the experiment to ensure accuracy and consistency in the results.

The results showed that substrate characteristics had a significant impact on print contrast values. The Chromo substrate demonstrated better print contrast performance for Cyan, Magenta and Yellow, indicating superior sharpness and improved color reproduction. This enhanced performance can be attributed to the smooth, coated surface of Chromo, which supports uniform ink transfer and better dot formation. On the other hand, the PE White substrate showed higher print contrast for Black, indicating stronger black density and better tonal reproduction, owing to its non-porous surface and effective UV LED curing.

The study concludes that substrate selection plays an important role in optimizing print quality in flexographic printing. Overall, the Chromo substrate was found to be more suitable for achieving better color reproduction and print sharpness, while PE White performed better in terms of black print quality. These findings offer valuable insights for improving print consistency and enhancing production efficiency in flexographic printing applications.

Keywords: Flexography Printing, Print Contrast (PC), Chromo Substrate, PE White Substrate, UV LED Ink, Print Quality, CMYK.

Introduction

Flexographic printing has evolved into one of the most widely adopted printing processes in the packaging and label industry due to its versatility, high-speed production capability and compatibility with a wide range of substrates (Kipphan, 2001). [1]

In recent years, increasing demand for improved print quality, sustainability and energy efficiency has led to the adoption of advanced ink curing technologies, particularly UVLED curing systems (Bould, 2019). Alongside these technological developments, substrate selection has become a critical factor influencing final print appearance and performance. [2]

Substrate-based substrates continue to dominate flexible packaging, labels and commercial print applications because of their printability, recyclability and cost effectiveness (Mangin & Vähä-Nissi, 2018). [3]

Among these chromo and PE White Substrates are extensively used due to their differing surface characteristics and functional properties. Chromo substrate typically features a semi-coated or

pigmented surface with moderate smoothness and absorbency whereas coated substrate contains one or more coating layers that enhance surface uniformity, brightness and gloss (Bristow, 2010). [4]

Print quality in flexographic printing is governed by a complex interaction between ink properties, printing parameters and substrate surface characteristics (Hladnik & Muck, 2002). [5]

Parameters such as optical density, dot gain, tonal value increase, line sharpness, print contrast and gloss are highly sensitive to substrate absorbency and surface roughness (Sharma, 2018). [6]

Research has consistently shown that porous substrates tend to promote ink penetration, which can reduce color strength and cause dot spreading whereas coated surfaces generally enable better ink hold-out and sharper image reproduction (Novak et al., 2021). [7]

The introduction of UV-LED inks has further altered ink substrate interactions in flexographic printing. UV-LED inks cure through photopolymerization when exposed to narrow-band ultraviolet radiation, producing instant curing, low heat generation and high chemical resistance (Ledbury, 2020). [8]

Compared to conventional solvent or water-based inks, UV-LED inks form a polymerized ink film predominantly on the substrate surface, making substrate smoothness and coating integrity even more critical for achieving consistent print quality (Xu & Li, 2020). [9]

Several studies have highlighted that coated substrates demonstrate superior performance with UV-curable inks due to reduced ink absorption and improved surface curing efficiency (Horiuchi, 2021). [10]

Conversely, chromo substrates, due to their semi-porous structure, may exhibit increased dot gain and variability in ink density unless printing parameters are carefully optimized (Reiser, 2017). This variation becomes particularly relevant in high-resolution flexographic applications, where precise dot reproduction and color stability are essential. [11]

Print quality evaluation in flexography has progressed from subjective visual assessment to objective measurement using densitometry, spectrophotometry and microscopic image analysis (Gaspar, 2019). [12]

Research Objective

This study aims to systematically evaluate and compare the print quality performance of chromo substrate and PE White Substrates when printed using the flexographic process. The objectives include examining how each substrate influences key print quality parameters such print contrast and overall visual consistency. The research intends to identify the factors that contribute to performance differences between the two substrate types and assess their suitability for various flexographic applications. Ultimately, the study seeks to generate evidence-based insights that can guide material selection and optimize print quality outcomes in flexographic printing.

Objective of this paper is to evaluate and compare the print contrast performance of UV LED Ink on chromo and PE White substrates in Flexographic printing for determining the most suitable substrate for better print quality.

Research Methodology

This study uses an experimental approach to compare the print quality of chromo substrate and PE white Substrates using flexographic printing with UVLED ink. A standard test chart with halftones, solids and fine details will be printed on both substrates under the same printing conditions. Printed samples will be measured using tools like a densitometer and spectrophotometer to check print contrast. Visual observation will also be done to note any quality differences. The collected data will be compared and analyzed to identify how each substrate performs and which one provides better print quality in UV-LED flexography.

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Data Collection & Analysis

The collected print quality data will be systematically analyzed to compare the performance of Chromo and PE White substrates. Print Contrast (PC) value were measured and recorded each color channel (CMYK). The average value will be represented using tables and graphical analysis to evaluate substrate performance.

Table.1. Average Print Contrast results of Chromo and PE White Substrate (Average 50 Sheets)

Average	Cyan	Magenta	Yellow	Black
Chromo	43.09	33.52	36.49	41.72
PE White	40.25	27.21	35.98	48.67

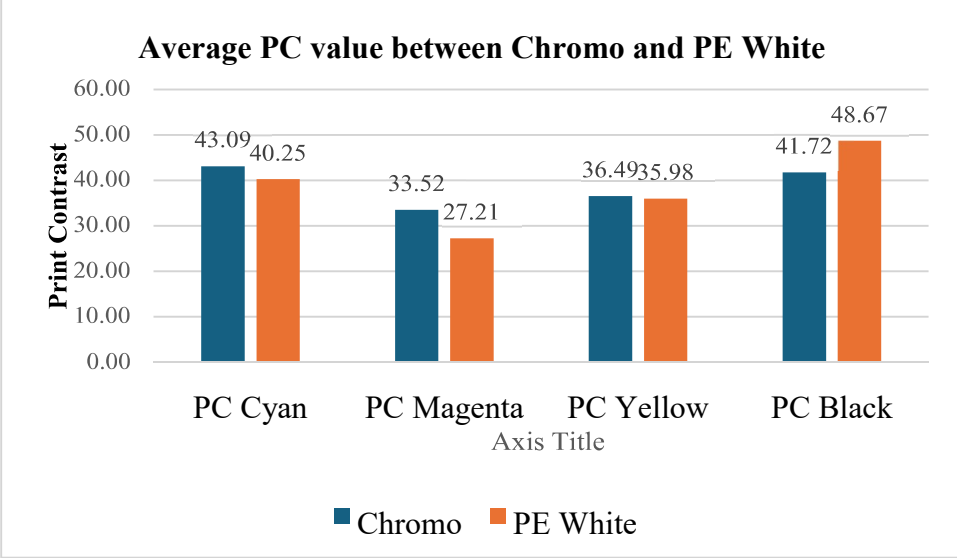

Figure 1. Average PC value between Chromo and PE White

The table presents the average Print Contrast (%) values for the CMYK process colors printed on Chromo and PE White substrates using the flexographic printing process. Print contrast is a key indicator of a printing system's ability to reproduce shadow details and tonal differences, with higher values representing better image contrast and improved print quality. The results indicate that Chromo achieved higher print contrast values for Cyan (43.09%), Magenta (33.52%) and Yellow (36.49%) compared to PE White, which recorded 40.25%, 27.21%and 35.98%, respectively. This suggests that the Chromo substrate provided better tonal reproduction and greater contrast for these three process colors. PE White exhibited a significantly higher print contrast for Black (48.67%) than Chromo (41.72%), indicating superior shadow detail and black image reproduction on the PE White substrate.

Result and Discussion

The Print Contrast (PC) results demonstrated that Chromo provided higher contrast values for Cyan, Magenta and Yellow, leading to clearer tonal separation and sharper image quality. In comparison,

PE White showed better Black print contrast, which enhanced shadow detail and overall image depth.

Conclusion

This study looked at how UV LED ink performs in terms of print contrast on two substrates Chromo and PE White using flexographic printing. The results made it clear that substrate characteristics have a real impact on print quality and tonal reproduction. For Cyan, Magenta and Yellow, Chromo consistently produced higher print contrast values than PE White pointing to sharper detail, better dot reproduction and more consistent color output. This is largely because of Chromo's smooth, coated surface which allows ink to transfer more evenly. PE White on the other hand, performed better when it came to Black showing stronger density and improved tonal reproduction likely a result of its non-porous surface combined with effective UV LED curing. Taken together these findings suggest that Chromo is the better choice overall for color reproduction while PE White has a clear edge for black print quality. This reinforces just how important substrate selection is when it comes to getting the best results in flexographic printing.

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