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Comparative Print Quality Analysis Of Solid Ink Density Of Solvent And Uv-Based Inks Used In Flexographic Printing Process

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Abstract
This research paper conducts a comparative evaluation of print quality using two different ink types i.e. UV-curable and Solvent-based inks printed with the Flexographic Printing Process on Polypropylene (PP) substrates. Polypropylene is extensively utilized in packaging applications but poses printing challenges due to its inherently low surface energy which affects ink adhesion and print clarity. To assess how each ink performs on PP, Solid Ink Density (SID) test was carried out to quantify the print quality. The findings reveal that UV curable inks deliver higher SID as they exhibit higher ink holdout after the curing. Conversely solvent based inks dry through evaporation which is a slower process that tends to cause more ink diffusion resulting in less dense inks.
Keywords: - *Flexographic printing, Polypropylene substrate (PP), UV ink, Solvent-based ink, Print Quality, Solid Ink Density.*

INTRODUCTION

Flexography printing is a modern printing process as it was developed during the mid19's. Flexography is regarded as upgraded version of letterpress. It has image area in recessed form. As its name suggests flexography means printing from flexible printing method. This method is widely used due to its flexibility (Baral et al., 2017).

The quality of printing depends upon the printing plate to be used. The characteristics of the printing plate should match the characteristics of the substrate and ink both. There are basically two types of the flexo plates: rubber plates and photopolymer plates. Rubber plates are the oldest and first types of flexo plates developed. These can be natural or synthetic rubber plates. Even today these plates are used in some of applications. Rubber plates are flexible and resilient plates. These plates have ability to transfer the ink effectively onto the different type of substrates (Kipphan, 2001).

Flexo presses are arranged in three ways: stack, inline, common impression cylinder. In stack configuration, one or more printing station are place one over another vertically. It includes two to eight separate colour stations with its own inking roller, plate cylinder and impression cylinder (Smyth, 2003).

One of the main advantages of the flexography printing is that it can print on wide variety of the substrates. It can print well on rough, smooth, absorbent and non absorbent substrates like Polypropylene (PP). Different type of paper and paper based products such as envelopes, folding cartons etc. are printed through this process (Baral et.al.,2017).

The compositions of inks contain colorant, vehicles, additives and solvents. These all substances vary according to the type of ink. In flexography the ink film thickness depends upon the nature of the substrate, job to be printed and speed of the press. Solvent based ink contains pigments, resin, organic solvent. It emits volatile organic compounds during evaporation which is not safe for the environment. UV is modern ink type used in flexography printing press. UV inks provide better colour quality and consistency. It cures by ultraviolet rays. UV inks take less clean up time. It is safer to environment and reduces air pollution. UV ink reduces dot gain and provides high colour strength (Baral et.al.,2017).

Research Objectives

Earlier Solvent based ink is widely used in flexography printing. The solvent based ink composed of solvents such as ethyl acetate, toluene. These compounds emit volatile organic compounds after drying the emission of VOCs is harmful for workers health and environment. After considering these issues Solvent based ink is replaced UV based ink. UV based inks cure instantly through photopolymerization, eliminate VOC emissions and provide higher durability. Now the study about print quality gap of both inks.

1) To compare the Solid Ink Density of Solvent and UV based inks on Polypropylene substrates in flexographic printing process.

RESEARCH METHODOLOGY

A quantitative experimental approach will be used to compare the print quality of UV and solvent based inks in the flexographic printing process. Controlled printing trials will be conducted to measure key print parameters. The assessment is done using solid ink density (SID). This Parameter is tested on average of 50 printed sheets at a time to maintain consistency of results and to allow reliability. UV Based and Solvent Based inks were used and Polypropylene (PP) is used as the substrate. Using a master test chart printing trials were carried out under controlled conditions. Solid ink density was measured with a densitometer.

Data Collection and Analysis

Comparing print quality of solvent and UV based inks on polypropylene involves evaluating solid ink density which affects colour vibrancy and sharpness. UV inks cure instantly for sharper prints while solvent inks dry slower causing more ink spread on the low energy PP surface.

Average SID comparison

Table.1. Average SID Comparison of Solid Ink Density of Solvent and UV Based Ink on PP substrate

Average of inks (50 Printed Sheets)	Cyan	Magenta	Yellow	Black
Solvent Based Ink	1.83	1.58	1.51	2.10
UV Based Ink	1.93	1.65	1.59	2.23

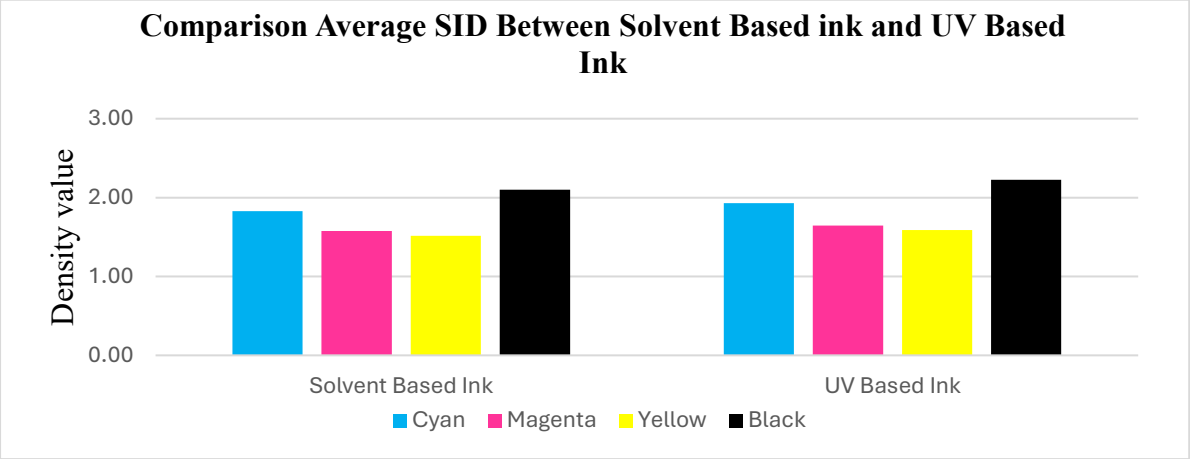

Figure.1. SID (Average 50 sheets) of Solvent and UV Based Inks

Densities of Solvent based ink and UV-based ink on PP Substrate showed variations that were clearly but slightly different. Solvent based ink obtained 1.83 Cyan, 1.58 magenta, 1.51 yellow and 2.10 black. UV-based ink obtained 1.93 Cyan, 1.65 magenta, 1.59 yellow and 2.23 black. Thus, the average density of UV-based ink is higher than the solvent-based ink. Solvent Based Inks evaporates and sometimes gets absorbed unevenly. UV inks cure instantly with UV light, forming a film on the surface without penetration. This means more colour remains on the surface and resulting in higher optical density.

Solvent Based Inks evaporates and sometimes gets absorbed unevenly. UV inks cure instantly with UV light, forming a film on the surface without penetration. Solvent Based Inks often produce lower measured density on polypropylene substrate because of poor wetting/adhesion. After printing, solvent evaporates, leaving the pigment. Pigment concentration is limited, since too much pigment can cause poor transfer, blocking or drying issues. UV Based Inks cured instantly by UV Light, ink film becomes solid almost 100%. Higher pigment loading possible, the cured film is thicker, denser and fully sits on the surface of substrate. Gives higher density and colour strength compared to the solvent inks.

RESULTS AND DISCUSSION

The analysis revealed that UV-based inks achieved higher solid ink density values compared to solvent based ink. UV inks produced denser and more uniform colour strength across CMYK separations. This is because UV inks cure instantly when exposed to ultraviolet light, forming a hard polymer layer on the

non-absorbent polypropylene (PP) substrate. The curing mechanism locks pigments on the surface preventing penetration or spreading which directly enhances density. Solvent-based inks rely on evaporation of solvents to dry. During this process part of the pigments film becomes uneven or slightly diluted which reduces optical density. Consequently, solvent-based prints appeared visually lighter and less saturated than UV prints.

CONCLUSION

After careful calculation, analysis and interpretation of the data, it is concluded that in the case of SID, UV inks outperform the solvent-based inks. UV inks provide higher density because of their better ink holdout after the curing process. This superior performance is attributed to the instant curing process of UV inks, which significantly prevents ink spreading or absorption, resulting in clearer and more vibrant prints compared to the slower drying solvent inks.

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