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Comparative Analysis Of Solid Ink Density Of Petroleum And Vegetable Oil (Soya) Inks On Coated And Uncoated Paper Stocks

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Abstract
Solid ink density (SID) has continued to be a basic parameter used to evaluate the print quality of the offset process. This paper gives a comparative evaluation of SID among Petroleum oil-based inks and Vegetable Oil (soya) based inks on various paper stocks. A series of printing trials were performed systematically on two substrate types i.e. coated paper and uncoated paper using a standardized CMYK test chart which facilitates uniformity in the experiment. The testing was done on fifty printed sheets in standard condition to minimize variability and set in the statistical reliability of the measurement. The results demonstrate that the Petroleum based inks always achieved slightly higher SID values in all the process colours (C,M,Y, K)as compared to the Vegetable Oil (Soya) inks. When applied on coated surfaces the differences between the two ink systems were not very drastic as penetration of the ink was restricted and thus the results of both ink systems yielded acceptable density. But on uncoated substrates where the density was highly affected by the ink absorbency, petroleum inks had a distinct advantage in Cyan and Magenta channels. The findings suggest that petroleum inks have an advantage when it comes to bigger colour saturation and deeper tonal reproduction. However, inks made of vegetable oil (Soya) base provided the average density values in terms of reasonable print quality range. On a perspective the analysis finds that vegetable oil (soya) based inks are a possible innovation to replace Petroleum based systems which have a high quality of prints and are useful in making a practice of offset printing a responsible effort to the environment.
Keywords: *Solid Ink Density, Petroleum based Inks, Vegetable Oil (soya) based Inks, Coated Paper, Uncoated Paper, Sheetfed Offset Printing, Print Quality Evaluation.*

INTRODUCTION

Printing has been one of the major inventions in the history of mankind. Printing refers to the art and science of reproducing the replicas from the original with the help of suitable printing technique on desired substrate or surface. In the earlier time hand writing was used as a printed medium but with the invention of printing taking impression has been more faster and efficient alternative to handwriting or drawing especially when printed materials requires to be produced on a larger scale (Baral, 2010).

Printing is a medium through which the type of ideas, thoughts, feelings and understanding are conveyed and delivered to the bigger community. In general printing describes a process that should be able to reproduce a single or more copies of an original image. It has been the largest contributions that ever made by man because it has provided a reliable means of storing and transferring of information across time periods and geographical and regions with diverse classes of people. The problem going into the printing is that the invention of printing transformed the world in that manner that Time magazine referred to it as one of their top projects that have been accomplished during the past millennium. Printing is normally described as the duplication of written document, graphic or image designs into an assorted medium that is recognized as the substrate. Such substrates may be made of paper, paperboards, plastic films, metal foils, textiles, laminated and other such material. The given process is usually associated with the technology of the graphic arts which entails the usage of a few updated ways. Whereas the traditional printing was entirely mechanical and it was utilized to print extensive quantities of images the latest printing technologies are a blend of photomechanical, chemically based, laser-based and digital electronic printing technologies that produce accurate and has capability to reproduce images of various kinds in a wide variety of ways (Baral, 2010).

The coated paper consist of incorporation of materials such as clay or calcium carbonate to enhance surface gloss, smoothness and ink containment. Gloss, satin and matte are finishes offered in coated papers that produce sharp and vivid prints with different levels of shine hence their popularity in high end prints such as magazines and brochures. Paper without the coating does not have this coating thus

absorbing ink more and making images less firm. It is appreciated due to its natural textures like wove, linen and laid and are used in stationeries, invitations and high quality brochures. In general coated papers are more robust and accurate in image representation whereas the uncoated papers are more classy in appearance and should be used in writing (Singh et al., 2017).

Generally printing inks consist of three major components which include a carrier (the carrier media could be either water, solvent or oil), a colourant (an ink colourant is either a pigment or dye) and a binder (a resin). Depending on the technique of printing used as well as the substrate used these factors are a determinant in the formulation of these components. In offset lithographic printing by far the most common use is the conventional drying oils such as linseed, tung and olive oils in conjunction with the non drying petroleum derived mineral oils. In the manufacture of varnish solid resins are dissolved in non-volatile oils and these oils can provide much desired properties of gloss, adhesion and stability. Most sheetfed offset inks consist of 50-70 percent mineral or vegetable oil which is used as the solvent, pigments, resins and other additives making the remainder (Aydemir et al., 2018).

Research Objectives

1. The purpose of the experiment is to measure the Solid Ink Density (SID) of petroleum-based and Vegetable Oil (soya) based inks in sheetfed offset printing.
2. To examine the influence of coated as well as uncoated paper substrates on SID values.

RESEARCH METHODOLOGY

Experimental research design was used in assessment of solid ink density (SID) of petroleum based and vegetable oil (soya) based inks in four colour sheetfed printing.

The general formulation of sheetfed offset ink typically incorporate several components in a definite proportion. Pigments and fillers contribute 15–22% as dispersed particles while hard resins acting as dissolved polymer binders account for 20–30%. Alkyd resins (in form of liquid polymers) are present at 8–12%. Triglycerides classified as drying or semi-drying oils make up 10–25% and mineral or vegetable oils serving as non-drying oils fall within 15–25%. Additives such as waxes, driers and antioxidants are incorporated at 3–5%.

Comparative analysis shows that vegetable oil (soya) based ink contains 21% solids, 28% triglycerides, 16% mono-ester vegetable oils, 2% mineral oil and 33% others. Petroleum/ mineral oil based ink on the other hand is composed of 21% solids, 18% triglycerides, 24% mineral oil, lacks mono-ester vegetable oils and includes 37% other materials mainly binders and additives (Strom, 2005).

To be reliable SID was assessed on a range of 50 printed sheets. The CMYK inks available commercially were applied to coated (90 gsm) and uncoated (90 gsm) substrates. For printing a Komori 20 x 28 inch four colour sheetfed offset press was used for printing of the test charts this gives the press high speed production and ink and water balance. The density of solid ink was measured using X-Rite e-Exact Spectro-densitometer. An empirical comparison of petroleum and soybean inks was made with statistical analysis of averaged SID data.

Data Collection and Analysis

Average SID comparison

Table.1. Average SID Comparison of Petroleum Based Ink and Vegetable oil (soya) based ink on Coated Papers

Average of inks (50 Printed Sheets)	Cyan	Magenta	Yellow	Black
Petroleum based Ink	1.49	1.47	1.04	1.60
Vegetable oil (soya) based ink	1.42	1.43	1.02	1.53

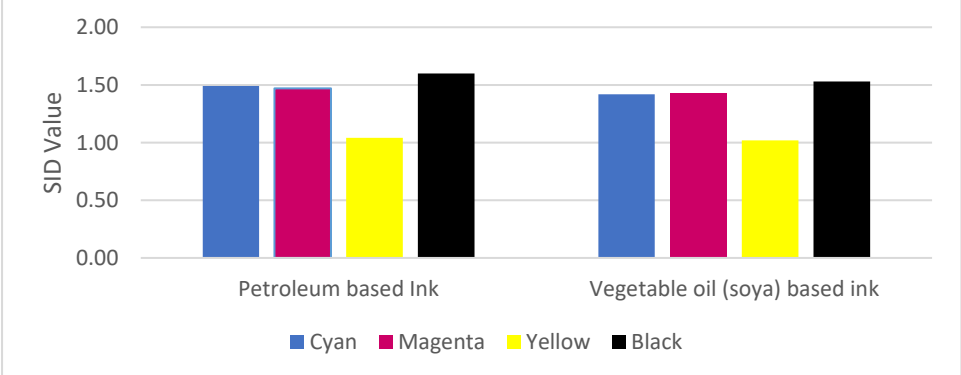

Figure.1. SID (Average of 50 Sheets) of Petroleum ink and Vegetable oil (soya) based ink on Coated Paper

Densities of petroleum and vegetable oil (Soya) based inks on coated paper showed variations that were clearly but slightly different. Petroleum inks obtained (Average of 50 sheets) 1.49 for cyan, 1.47 for magenta, 1.04 for yellow and 1.60 for black. Comparatively the vegetable oil (soya) base inks were a little lower with 1.42 for cyan, 1.43 for Magenta, 1.02 for Yellow and 1.53 for Black.

Results display that petroleum inks always attained better density among the process colours. This implies that petroleum inks emit a bit of better colour saturation and darker tonal reproduction on coated substrates and vegetable oil (Soya) base inks are even a bit lighter yet in the acceptable branches of quality.

Table.2. Average SID Comparison of Petroleum Base Ink and Vegetable oil (soya) based ink on Uncoated Papers

Average of inks (50 Printed Sheets)	Cyan	Magenta	Yellow	Black
Petroleum based Ink	1.06	1.15	0.93	1.24
Vegetable oil (soya) based ink	0.97	1.11	0.90	1.21

In the uncoated paper the total densities of the two ink types were low because in such a substrate the material was absorbent. Cyan recorded an average density of 1.06, 1.15 for magenta, 0.93 for yellow and 1.24 for black. Vegetable oil (soya) based recorded an average density of 0.97 for cyan,1.11 for magenta,0.90 for yellow and 1.21 for black.

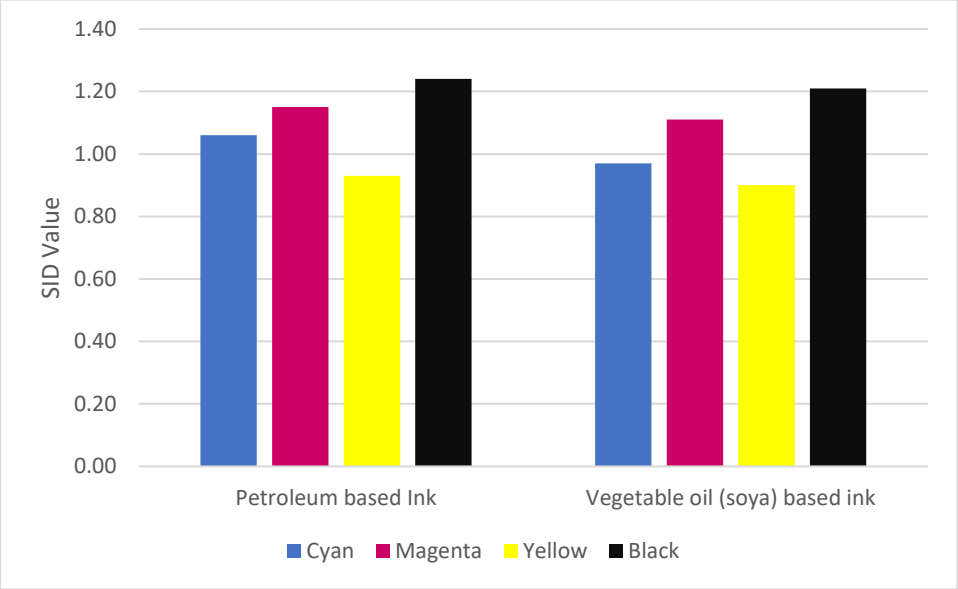

Figure.2. SID (Average of 50 Sheets) of Petroleum ink and Vegetable oil (soya) based ink on Uncoated Paper

Once again vegetable oil (soya) based inks demonstrated slightly smaller density values of all colours. The difference was the largest in Cyan (0.09 difference) whereas there was little variation in the Yellow and Black channels. The values of density lower in general testify that the uncoated paper decreases the thickness of the ink film throughout absorption.

These results on all coated papers and uncoated papers indicate a similar trend that petroleum inks have a little greater soild ink density than vegetable oil (soya) based inks in all four process colours. The differences are not so dramatic but systematic with the petroleum inks having greater pigment holdout and surface coverage.

On coated paper the disparities are comparatively little because the surface is smooth which restricts the ink penetration and enables the two types of inks to have greater densities. The gap is further exaggerated on uncoated paper particularly in Cyan and Magenta indicating that petroleum inks deal with substrate absorbency more efficiently and therefore retain some colour strength.

The Vegetable oil (soya) ink though could still offer competitive density levels and deliver results within acceptable print quality margins. Their performance although lighter indicates that in case the colour management adjustments have been made they can be used as the replacement of petroleum inks without much visual quality loss.

Petroleum inks tend to produce greater density values on coated and uncoated papers to achieve a greater strength of colours and a darker tonal reproduction. Vegetable oil (soya) based inks although with slightly lower densities give uniform and balanced results. Their environmental benefit together with an acceptable performance on density makes soy inks a viable and sustainable alternative to offset printing especially when used with prepress compensations to compensate the difference in density.

RESULTS AND DISCUSSION

Petroleum inks or Mineral Oil-based inks (C 1.49, M 1.47, Y 1.04, K 1.60) had a slightly higher density on the coated paper than on the Vegetable oil (soya) inks (C 1.42, M 1.43, Y 1.02, K 1.53). The variations were also slight and these are attributable to a smooth coated surface which mentioned that the penetration of ink is limited. There was a more distinct advantage in petroleum inks in uncoated paper over Vegetable oil (soya) based inks (C 1.06 vs 0.97; M 1.15 vs 1.11; Y 0.93 vs 0.90; K 1.24 vs 1.21) with Cyan registering the greatest difference (0.09). This is how this implies that petroleum inks hold a better pigment high and richer assortment on porous materials.

In terms of lighter density the Vegetable oil (soya) inks also gave a balanced result and repeated sheets had unchanged performance. Soybean inks are able to reach similar visual quality with proper calibration or increased ink film thickness with a slight adjustment.

In all experiments petroleum based inks formed moderately more densities in the CMYK channels than Vegetable oil (soya) based inks. In coated paper differences were minimal because penetration of ink was constrained by smooth surface. But on paper without any coating where absorbency effectively lowered the overall density the distance between them was greater it was especially in Cyan and Magenta. Such findings affirm that petroleum inks have better pigment retention and density. However; vegetable oil (soya) based inks continued to be satisfactory in terms of Solid ink density indicating that they can be useful replacements in case prepress compensation is implemented.

CONCLUSION

Petroleum inks give superior SID in on coated as well as uncoated paper stocks compared to the soya based inks. Nevertheless, due to their stable and competitive behaviour the density results of vegetable oil (soya) inks demonstrate their sustainability as a viable alternative.

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