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Effect of Drying Temperature on Print Quality for Offset Printing with Soybean Ink

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ABSTRACT

This study aims to investigate the effect of temperature in drying unit on printing quality in the aspect of color. Four levels of temperature, consisting of 65, 75, 85, and 100 C°, were conducted. The printing condition belongs to ISO12647-2.[3,4,5] At the beginning, the temperature of drying unit at swan neck of offset printing machine was approximately 33 C° as same as outside temperature in Bangkok and increases to 65 C°. The press was run continuously without operator interference and 1,000 sheets were printed, from which 278 were randomly selected for analyzing. Then, a next temperature was conducted. The color gamut of each temperature setting up was analyzed. The expected results will show the difference of density and color gamut when the temperature in drying unit change. The result of this study might be used as a guideline for operating drying unit in offset printing system.

Keywords: Drying temperature, Offset printing, Print quality

1. INTRODUCTION

In recent years, soybean ink was used as conservation environmental aspect. It becomes famous in printing house because of a renewable resource and conserving the finite petroleum supplies. Soybean oil does not evaporate the way petroleum does, and does not release harmful VOCs into the air that contribute to smog. It can decreases VOC emissions because it contain less than half the VOCs, require less alcohol, work more easily with alcohol substitutes, and can be washed up without solvents. These inks reduce emissions from >30% VOC to as low as 2 - 4% VOCs [1]. However, one of disadvantages of soybean ink is slower drying time, particularly on uncoated paper because it penetrate paper more slowly and is set primarily by oxidation. This ink contain amount of petroleum and soybean oils varied from printing system and color of ink. To achieve appropriate drying times, a proper amount of soybean oil is required. The higher the soybean oil is, the higher the temperature for drying is. This issue counteracts the environmental benefits of using soybean ink [2]. Moreover, the color of some colorant is changeable by ray and heat.

Green printing is defined as a movement in the printing industry to use natural resources to develop sustainable solutions for the future of printing and print advertising (Argent, 2009). Choosing low-volatile organic compound (VOC) inks, using recycled or tree-farmed paper, working with local suppliers, and reducing the use of chemical products in the plate-making and printing areas are all part of this effort. In this article, we discuss using soy oil based ink or vegetable oil based ink for offset printing as one of the elements of green printing.

There are many environmental and technical design advantages to the use of vegetable-based oils. Vegetable oil in printing inks is a renewable resource and conserves finite petroleum supplies. Soybean oil does not evaporate the way petroleum does, and soybean oil does not release harmful VOCs into the air that contribute to smog. Petroleum-based inks contain relatively high levels of VOCs, which are regulated by the updated Clean Air Act, as are the alcohol in fountain solutions and the solvents used to wash presses between jobs. VO inks will reduce VOC emissions because they contain less than half the VOCs, require less alcohol, work more easily with alcohol substitutes, and can be washed up without solvents. These inks reduce emissions from >30% VOC to as low as 2 - 4% VOCs (Eco- and Mild Solvent, 2009). The printing press can be cleaned with a water-based cleaner, replacing a high-solvent cleaner and further reducing VOC emissions. The printed product is easier to de-ink in the recycling process and results in a less hazardous sludge (Evans, 1997).

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However, the disadvantages of VO inks include their slower drying time, Most VO inks contain some petroleum oil to speed up drying or setting time and the amount of vegetable oil replacing the petroleum oil can vary by manufacturer and by press type and ink color. Pure formulation VO inks cannot be used in heat-set ink processes. To achieve appropriate drying times for these processes, vegetable oil may replace a portion of the petroleum oil. If no petroleum oil were used, print shops would increase their energy use for heating and drying the ink, thus counteracting the environmental benefits of using VO inks (Alternatives to Petroleum, 1997).

Print attributes are the individual characteristics within the printing process that can be measured and monitored during production so as to maintain a consistent quality. The most commonly monitored print attributes, and the ones of most interest to the researchers, are solid ink density, ink trapping, hue error, dot gain, print contrast, grayness, and gray balance (Lustig, 2001).

The purpose of this study is to identify the effect of temperature in drying unit on printing quality in the aspect of color differences in color gamuts of soybean inks that are used in multicolor (CMYK) offset printing. The following questions were investigated. Is there a difference in the color gamuts of the Soybean inks when temperature in drying unit increase?

2. RESEARCH METHODOLOGY

This research included an experimental research method. A layout was created for a 21.5" x 25.5" press sheet utilizing a custom Four-Color target. The target contained the following elements: CMYK tone scale, RGB overprints, color control bars, and other multicolor images. During the printing, these elements are used to evaluate the subjective and objective aspects of the image quality (see Figure 2). Figure 2 represents a partial portion of this test target. The data contained in this study were obtained by measuring the printed patches of this target (see Figure 2).

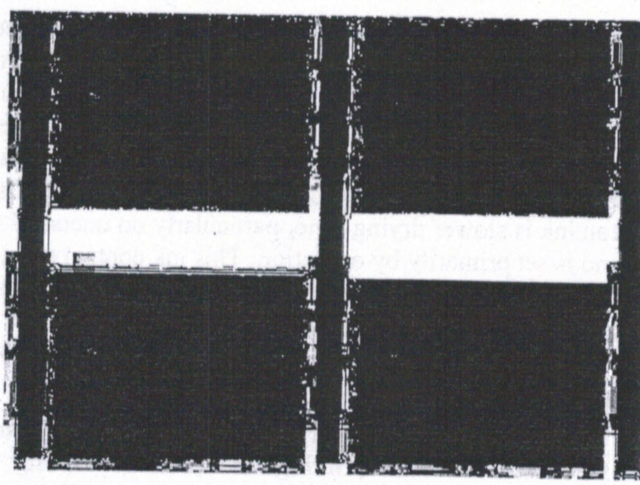

Figure 1. Four-color (CMYK) test chart.

The layout was processed through Prinergy Evo Raster Image Processor (RIP). It was output using a conventional halftone screen at 175 lines per inch (LPI), with elliptical dot shape by using the Creo Trendsetter Computer to Plate (CTP) device and two sets (VO and SB inks) of linear CMYK (four) offset plates were made, each set for the two types of ink. Linear plates were made by not using the previous dot compensation curve at the RIP in order to have input dots equal to output dots. Output dot values on the plates were measured and recorded for the plate curve (see Figure 3) by using Troika LithoCam plate dot reader via the LithoCam 2.5 interface application.

After the plates were made for the SB inks, a pilot test was conducted to achieve the target ink density values according to GRACoL standards. During the pilot test, 1000 (*N*) sheets were printed. Once density values had been achieved according to the standard ink density values, the press was run continuously without operator interference and another 1000 (*N*) test sheets were printed, from which a total of 278 (*n*) sheets were randomly selected for the analysis. The machine (ink/printing units) was cleaned for the second run. Table 1 presents the variables, materials, conditions, and equipment associated with the prepress and press parts of this experiment.

The same procedures were applied for printing with the VO inks. The sample size was selected in order of the specific confidence interval (a = 0.05). A random sampling technique was used to identify the sample size because of the large size of total population. During the printing, an X-Rite ATD Scanning Densitometer was used to control the solid ink density on the press. After the printing, an n X-Rite 528 Spectrodensitometer was used to collect the colorimetric and densitometer data from the sample. Christensen (1980) provides an objective method to determine the sample size when the size of the total population is known. The total population for this study is 1000 (N) printed sheets. The following is the formula to determine the required sample size. It was determined that the sample size for this study is 278 (n) printed sheets.

3. RESULT AND DISCUSSION

2.1 Data Analysis and Research Findings: Vegetable Oil-based Inks vs. Solvent-based Inks

A total of 278 randomly selected samples (printed sheets) were analyzed for each set of ink. Colorimetric and densitometer data were generated by using an X-Rite 528 Spectrodensitometer from the printed sheets. Descriptive and inferential statistics were the statistical procedures used to analyze the data. An independent samples one-tailed t-test was conducted to determine if any statistical differences exist between the mean scores of print attributes (dot gain and print contrast) of both inks. Colorimetric data and **ΔE** was used to compare the color gamuts of both inks. In comparing the differences between two colors, a higher **ΔE** is an indication of a greater color variation and lesser the **ΔE** is an indication of less color variation. However, the subjective judgment of color difference could differ from person to person. For example, people see colors in an image, not by isolating one or two colors at a time (Goodhard & Wilhelm, 2003). In addition, people see colors by mentally processing contextual relationships among colors where the changes in lightness (value), hue, and chroma (saturation) contribute independently to the visual detection of spatial patterns in the image (A New Test Method, 2003). The results of analysis are presented in the following section.

2.2 Color Variation in the Midtone (50%) dot area of Vegetable Oil vs. Solvent-Based Inks

The CIE L* a* b* values associated with the CMYKRGB colors in midtone (50% dot area) color areas of VO vs. SB inks are compiled in Table 3. Numerical and visually noticeable color differences (ΔE) were found when comparing the VO inks (color) with the SB inks in the midtone area of the printed image on all seven colors (CMYKRGB). VO inks produced higher L* a* b* values in yellow, red, and green inks (bigger gamut) than for SB inks. In contrast, both inks have not produced same/similar color gamut in the midtone areas (see Figure 6), except the printed proof consists of same colors in magenta, cyan, and blue. The 2D color gamut comparison (see Figure 6) reveals a significant color difference between the two inks.

	Vegetable Oil			Solvent			Color
	L*	a*	b*	L*	a*	b*	Difference
Color(s)		Color 1			Color 2		ΔE
		n = 278			n = 278		
Yellow	91.56	-4.84	46.23	91.23	-2.01	39.15	7.63
Red	70.43	27.88	26.95	72.17	27.63	22.97	4.35
Magenta	73.45	30.8	-4.38	72.80	33.17	-4.27	2.46
Blue	63.77	13.22	-18.68	63.03	12.52	-20.75	2.31

Color(s)	Vegetable Oil			Solvent			Color Difference
	L*	a*	b*	L*	a*	b*	
	Color 1			Color 2			ΔE
	n = 278			n = 278			
Cyan	74.38	-14.21	-19.23	78.69	-15.01	-20.88	4.68
Green	76.86	-21.99	-22.78	75.86	-21.58	15.00	7.85
Black	65.09	0.51	0.64	69.34	0.89	1.11	4.29

Table 2. Color Variation in the Midtone (50% Dot) area of CMYKRGB of Vegetable Oil vs. Solvent-Based Inks.

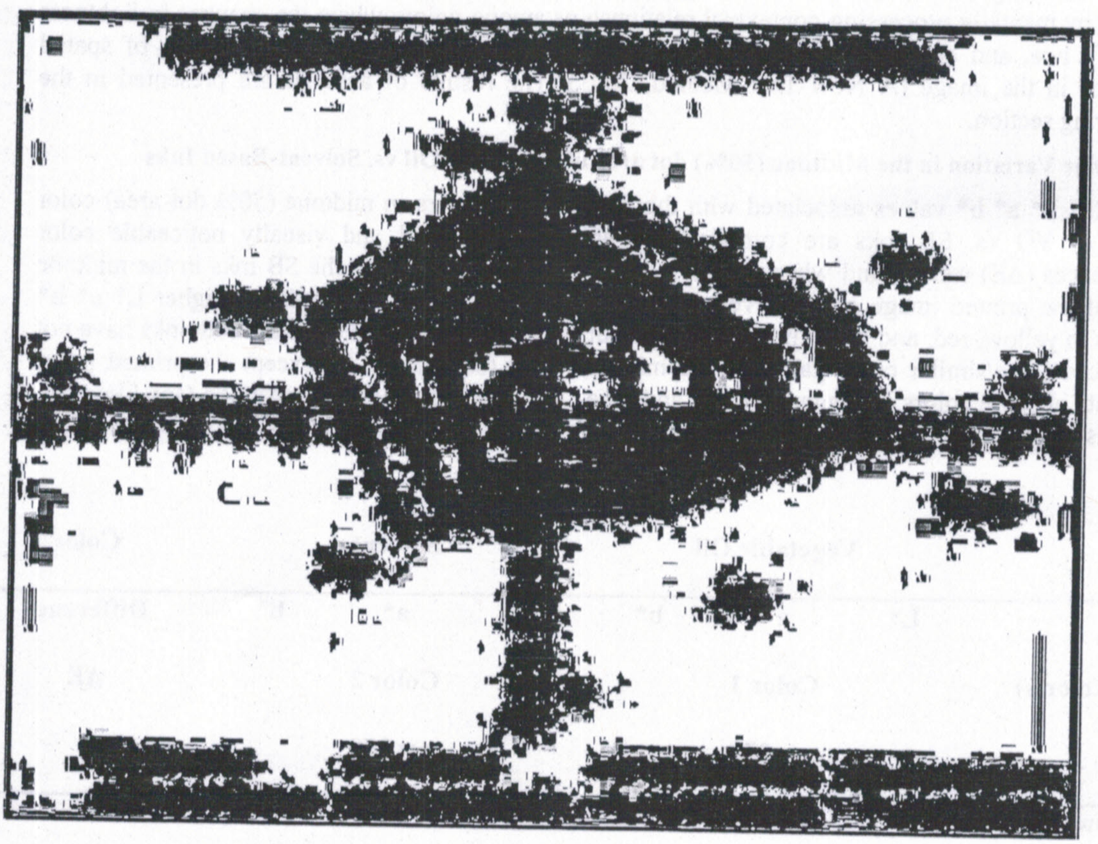

Figure 2. CIE L* a* b* 2D-model for VO Inks vs. SB inks CMYK color gamut comparison.

4. CONCLUSION

The conclusions of this study are based on results of the data analysis. The findings of this study represent specific printing or testing conditions. The screening technologies, paper, ink, dampening solution, film and plate imaging system, and printing process that were used are important factors to consider when evaluating the results. The findings of this study may not be generalized to other printing conditions. However, the findings of this research suggest that VO inks provide greater print contrast than do SB inks under specific printing conditions. This provides greater detail in the shadow areas (CM) of printed images. The black and yellow inks' print contrast ran counter to this conclusion, which suggests the need to explore other factors or variables that may have contributed to this result. Variables to explore include print order or printing unit: ink color interaction.

SB inks had statistically significant higher levels of dot gain for three of the four ink colors. A lower dot gain in VO ink resulted in a better color gamut in the midtones and shadow areas. Again, further study is needed to attempt greater control of variables. A more deliberate process of press calibration would also be recommended in a future study. The margin for error is much smaller with SB inks, requiring a carefully calibrated and controlled press platform. Qualitative analysis is also something to be pursued. A panel of experts could provide qualitative analysis regarding their preference for one ink or the other.

In comparing the color gamut of both types of inks from highlight color areas to solid color areas, VO inks produced better visual colors than the SB inks. This suggests that the VO inks are environmentally friendlier and can be used for better color reproduction. This experiment revealed that the VO inks produce better colors than do SB inks. Green printing is an environmentally friendlier, healthier, and safer approach to printing that requires only a small amount of energy. The question is, how many printers are going green? Additionally, if printers are not doing so, why not? Answers to these questions would require additional study to determine the status of using VO inks in the printing industry..

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