Optimization of Printing Conditions to Achieve Effective Ink Transfer in Flexographic Printing.

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Abstract

This research aimed to study the factors affecting the ink transfer in flexographic printing, including ink temperature, and anilox roll. The research was experimental research by studying the ink transfer from anilox roller to plate and from plate to print substrate. The independent variables in the experiment were (1) the ink temperature with 5 levels: 25°C, 30°C, 35°C, 40°C, 45 °C, and (2) the anilox roller that used to transfer the ink to the plate having 3 resolutions: 1,000 lpi (volume of 1.7 cm^3m^2, 700 lpi, (volume of 3.5 cm^3m^2), 500 lpi (volume of 5 cm^3m^2). The print image was 7 screen tint of 100%, 90%, 70%, 50%, 30%, 10% and 5%. The dependent variables were the amount of printing ink and the tone value transferred from the anilox roller to the plate and from the plate to the printing substrates. From the experimental results, it was found that the ink temperatures of 25 °C and 30 °C was suitable for flexographic printing whereas the printing speed and anilox roll resolution did not affect the ink transfer from the anilox roller to plate and from plate to printing substrates.

Keywords: Ink Transfer, Printing Conditions, Flexographic Printing

Introduction

Flexography is a printing process derived from aniline printing as relief printing using flexible printing plate as the image carrier and low viscosity inks which make it suitable for use on almost any substrate. Over the past ten years, the role of flexographic printing technology has continuously concerned over quality printing for packaging industries. One of the reasons for the advantages of this printing system is the development of water-based inks to support the food and beverage packaging industry, being environmentally friendly printing. The method of applying ink to the flexographic plate is through engraved roller with a uniform etched cells (size, shape, and depth) called 'anilox roll'. The anilox resolution determines the volume of ink transferred to the plate and the plate transfers the ink film to the substrate by impression. [1] The cell count per inch or anilox resolution (lpi) should be 4-5 times greater than dot resolution on the plate to print a dot of as small as 4 % [2]. By examining the flexographic printing process, lots of variable parameters affect the ink transfer to print substrates to achieve good print quality. These includes ink temperature and anilox resolution.

This research aimed to study the printing factors affecting the ink transfer from the ink supply unit to the print substrates including ink temperature, anilox roll resolution to find out optimal printing conditions and enable to reduce printing problems and wastes.

Experimental Method

The experimental study was conducted by 1) studying problems on ink transfer and printed color at solid area and percent dot area 2) finding out possible factors on print image quality that actual encountered by flexographic printing houses 3) examining ink transfer at the laboratories by Flexi Proof Printer and printing samples by Rhyguan rotary flexography printing machine with varying anilox roller resolutions and ink temperature 4) evaluating the printed samples on ink transfer, print qualities affected by varied printing factors; the research framework shown in figure 1.

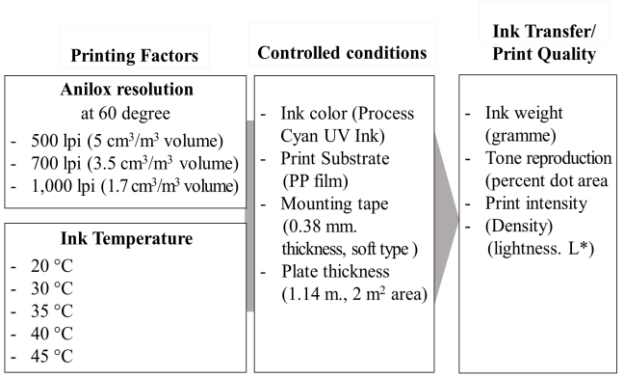


Figure 1. Research Framework

Ink Transfer Study

Three anilox rolls with the resolution of 500 lpi (5 cm^3/m^2 volume), 700 lpi (3.5 cm^3/m^2 volume) and 1,000 lpi (3.5 cm^3/m^2 volume) and flexographic plate with 1.14 mm. thickness and 2 m^2 print area were weighed by weighing scale before and after applying ink from ink supply unit to anilox rolls and from anilox rolls to printing plates. Those practices were done five times on Flexi Proof Printer under controlling ink temperature at five levels of 20°C, 30°C, 35°C, 40°C, 45°C.

Flexographic printing of the samples was carried out by

Rhyguan rotary printing machine on bi-axially oriented, glossy white polypropylene film of 50 µm. thickness (TAPPI T411) using Cyan UV ink with varied printing conditions of anilox resolutions and ink temperatures. Then the printing plates and the printed substrates (PP white film) were weighed before and after printing and calculated percent ink transfer in each printing conditions.

Print Quality Study

The Printed Samples of 100%, 90%, 70%, 50%, 30%, 10% and 5% dot area (figure 2) under studied printing conditions of anilox resolutions and ink temperatures were examined. The percent dot area, print density and Light value (CIELAB) were measured by X-rite e-Xact Portable Spectrophotometer.

Figure 2. Printed samples of dot area on PP white film

Results

Ink Transfer from Ink Supply to Anilox Roll

Experiment for ink transfer from ink supply to anilox roll was carried out with Flexi Proof Printer in the laboratory. The ink transfer from each resolution of anilox rolls showed different results. Different anilox resolution gave different ink transfer from ink supply onto anilox roll, as shown in Figure 3. The lower anilox resolution (500 lpi) gave the higher ink transfer while the higher anilox resolution gave the lower ink transfer. Ink temperature also affected the ink transfer, especially when the ink temperature was higher than 30°C. The ink transfer was gradually increase with the increase of ink temperature, which applied to all anilox resolutions.

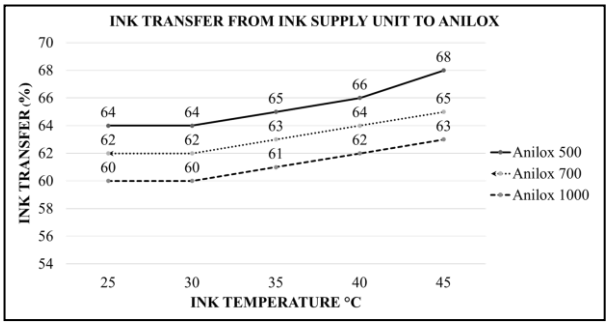


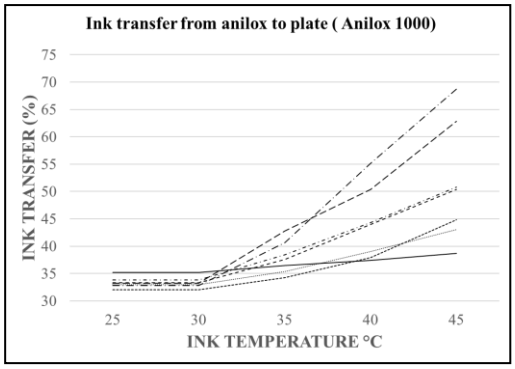
Figure 3. Ink transfer from ink supply unit to anilox roll

The ink viscosity measurement at each ink temperatures was examined by the average ink flow time (sec.) from Zahn cup no. 4 as shown in Table 1. As ink temperature got higher, the shorter time ink flow out of the Zahn cup. From standard conversion table, the measured flow times of ink were converted into ink viscosity. The data showed ink viscosity became lower when ink temperature got higher. However, the flow time of the ink in this study were between 18 – 35 second using Zahn cup no.4 which be suggested for flexographic printing. [3]

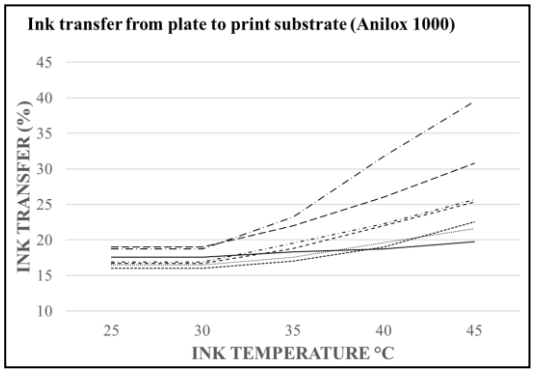
Table 1 Ink temperature affected ink viscosity

Ink temperature (°C)	Average time (sec.) Zahn cup no.4	Viscosity* (cP.)
25	35	444
30	34	429
35	30	370
40	26	311
45	23	266

The experiment for sample printing was carried out on Rhyguan rotary flexography printing machine in the printing factory. Samples of dot area on PP white film as shown in Fig 2. was cut from the printing roll and weight for the ink transfer. The ink transfer from anilox to plate and from plate to print substrate was normal transfer with the temperature of 25-30°C either using 1000 lpi, 700 lpi, and 500 lpi anilox roll. However, the ink transfer was increased when the ink temperature increase (more than 30°C), especially at the smaller dot area image. (5% - 50%) as shown in Fig 4 - 6.



(a) from anilox roll to plate

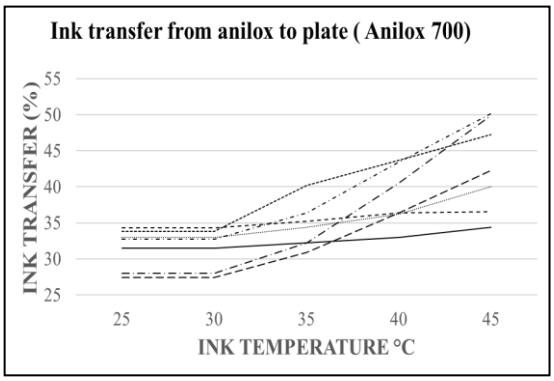


(b) from plate to print substrates

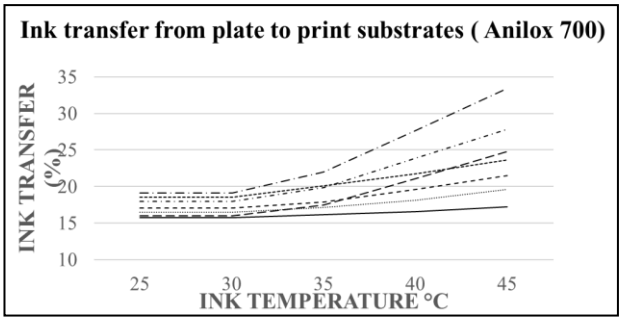
Plate 100%
Plate 90%
Plate 70%
Plate 50%
Plate 30%
Plate 10%
Plate 5%

Figure 4. Ink transfer from anilox roll 1000 lpi to print substrates

The higher anilox resolution (1000 lpi) cause more ink transfer in the small dot area (ie. 5%). However, the medium anilox resolution (700 lpi) and low anilox resolution (500 lpi) cause lower ink transfer increment in the small dot area. The dot quality of small dot from the printing can be less affected with the increase of ink temperature, as shown in Fig 5. and Fig 6.



(a) from anilox roll to plate



(b) from plate to print substrates

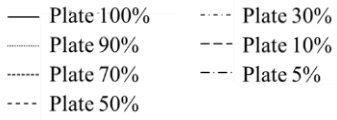
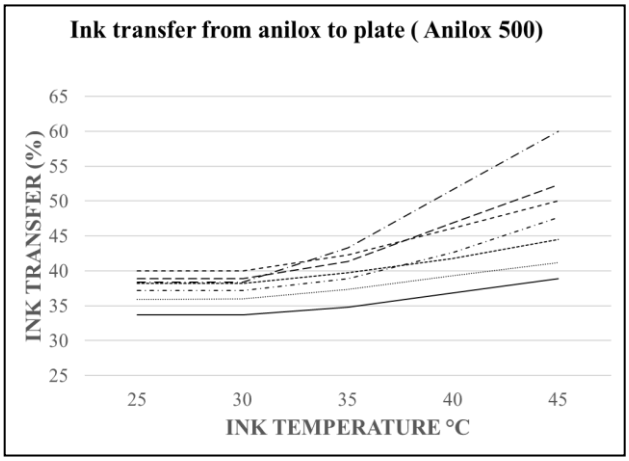
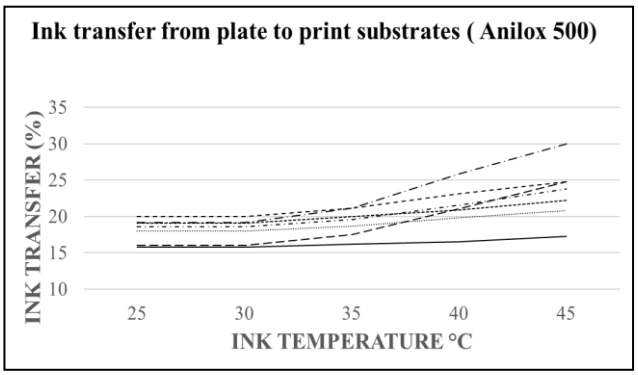


Figure 5. Ink transfer from anilox roll 700 lpi to print substrates



(a) from anilox roll to plate

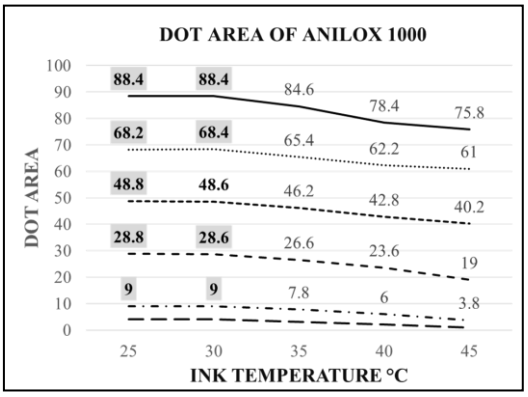


(b) from plate to print substrates

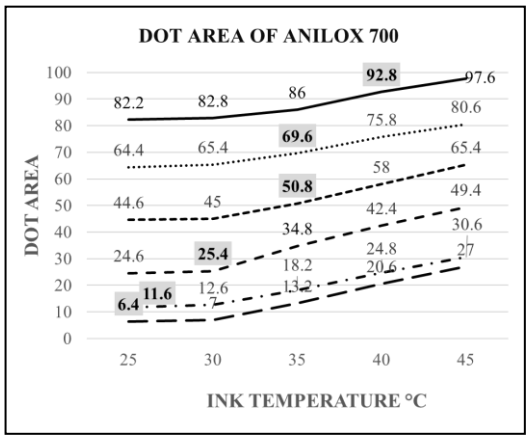
Figure 6. Ink transfer from anilox roll 500 lpi to print substrates

Print Quality of Printed Samples

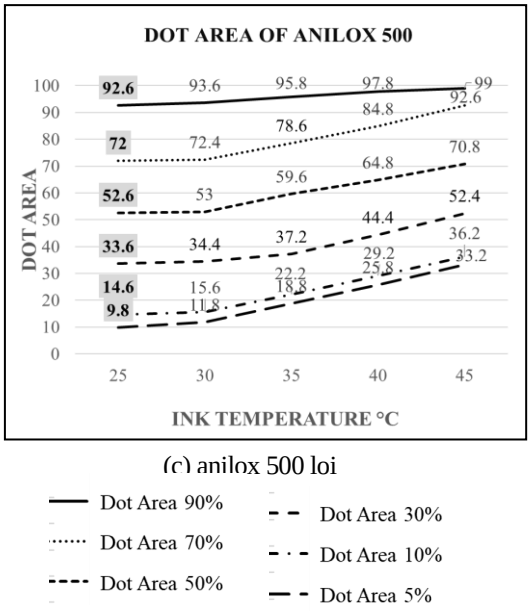
The print samples of dot area from 5% to 90% representing highlight, midtone and shadow of print image were measured the percent dot area to find out the printing conditions providing less dot gain and good print quality as shown in Fig 7.



(a) anilox 1000 lpi



(b) anilox 700 lpi

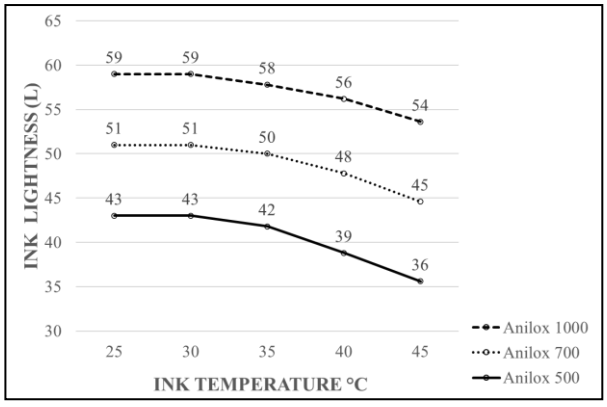


(c) anilox 500 loi

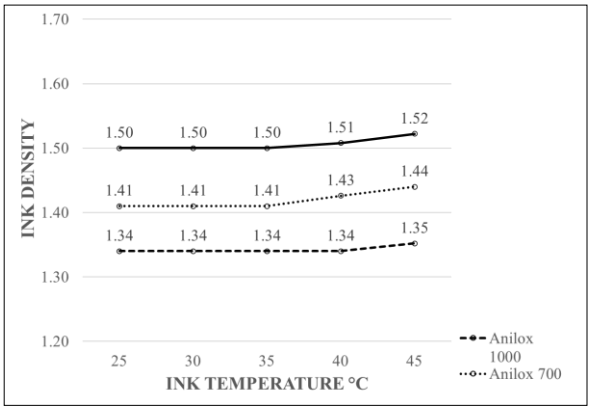
Figure 7. Dot area of printed samples

It is found that ink temperature should be controlled between 25 °C - 30°C either using anilox roll at high resolution (1000 lpi), medium resolion (700 lpi) and low resolution (500 lpi) to assure print quality during printing process.

The increased ink temperature more than 30°C also affected print density being higher and lower lightness of print color at solid area as shown in Fig 8.



(a) Ink Lightness



(b) Ink Density

Figure 8. Print Intensity of Print samples

Discussion and Conclusion

The print quality of flexographic printing was largely depended on the ink transfer properties. The ink temperature affected ink viscosity and ink flow onto anilox rollers. From this research, the temperature of 25-30°C was suitable for normal flexographic printing. The resolution of anilox roll also cause the variation of ink transfer. Other than that, the ink temperature variation also causes the ink transfer of different dot size images to reproduce differently, in this case, higher temperature cause higher ink transfer in the small dot area. However, as the suggested ink temperature range of 25-30°C, the printing speed and anilox roll resolution did not affect the ink transfer from the anilox roller to plate and from plate to printing substrates.

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