

The Impact of FM-AM Hybrid Screening and Am Screening on Flexographic Printing Quality

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Abstract:

There are many factors that have an effective impact on the quality of the printed image, one of these factors is halftoning which plays main role for controlling in the image details particularly in highlight areas, without the ability to adjust highlight areas the minimum dots will be lost on the plate and we will suffer to obtain an optimum image details.

Halftoning methods can be classified into three main categories, AM (Amplitude Modulated), FM (Frequency Modulated) and hybrid screening. This study investigates the effect of FM-AM hybrid and AM screenings on printing quality of flexography printing particularly in highlights areas and image. The study employs a test form that be generated in two screening techniques, the FM/AM hybrid screening technology (Kodak/ Maxtone) for highlights areas from 1-6% and the halftones areas from 7-99% were employed AM dots. After printing the measurements were evaluated. It is hoped that the results of this study can help Egyptian flexography printers to better understand the characteristics of both screening techniques to improve printing quality and achieve the highest customer satisfaction.

Keywords:

- *FM-AM Hybrid screening,*
- *AM screening,*
- *halftoning,*
- *bump up curve,*
- *pre-press,*
- *flexography*

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Introduction

The enormous changes in flexography printing in recent years concerning the printing quality achievable cannot generally be ascribed to a single revolutionary invention, but are the result of continuous developments to the complete system (J. Richter, 2004). The companies have developed innovative solutions that vanquish many of the limitations attendant in flexographic Pre-press and printing. These solutions try to improve smoother gradients, image details, dot gain and highlights areas, one of these developments is halftoning.

The transformation from a continuous tone image to a binary bitmap representation is called Halftoning also referred to as Screening. The most straightforward way of halftoning is to represent the average color of different parts of the original image by a so-called halftone cell (or halftone screen). The fractional area of the halftone cell that is covered by the ink should represent the average color of the corresponding area in the original image (Aijazi A., 2010).

In a black-and-white image, different gray tones can be simulated by printing a number of small dots larger or smaller. These small dots are arranged at regular intervals in a grid structure that is called a screen. The relationship of the dot size

to the screen mesh or halftone cell, to use the technical term, results in a dot percentage that gives the optical illusion of gray. Whether or not the individual dots can still be recognized depends on their size and on the distance from which they are observed (Heinrich, 2002). Digital halftoning classifies into three categories- AM (amplitude modulation), FM (frequency modulation) and FM-AM hybrid screening.

The Egyptian flexographic printers always use AM screening for production without attempting to use FM-AM hybrid screening either fear to convert to new screening technology that have not any information about or they don't try to experience it to explore the advantages using FM-AM hybrid screening particularly related to produce the highlights areas.

Due to the flexibility of the printing plate, flexographic printing has difficulties in producing highlight dots. This leads to use new screening technologies to solve this critical problem.

Literature Review

AM screening

The principle of conventional amplitude-modulated (AM) screening is that the distance between dots is fixed, and dot size is changed to simulate continuous tones. However, factors such as fixed screen angle, screen ruling, and screen

shape may cause depiction of the lighter and darker parts of the image to be inadequate (Hsieh, et al 2008), this makes AM screening a technique with good printing stability and low computational requirements and showing less dot gain in mid-tone areas (Paula,2014).



Figure 1: Am halftoning,

FM-AM Hybrid screening

Hybrid screening, or transitional screening, offers the advantages of both AM and FM screening technologies. Typically, it is a combination of AM and FM screening that produces the best output. Claims were made by many screening technology vendors that the idea of this screening technique grants a better dot gain curve. This new screening technology provides printers with a better approach to achieve greater print quality with less. In addition, the reasons to use hybrid screening are to achieve rich details in the highlight and shadow areas and to decrease graininess in the midtones .It is also developed to avoid highlight breaks in flexographic printing. Vendors claim that hybrid screening helps package printers to run solids, lineworks and halftone images on the same plate . An accuracy benchmark of printing presses is the first requirement in achieving optimum dot size when printing with hybrid screening (Wimonrat ,2006).

A hybrid screening technology that uses FM screening to enhance details in the highlight areas and uses AM screening for the other areas. It allows prepress operators to define transitional

points corresponding to flexographic platemaking and particular printing conditions. This technology reduces the tone break effect in flexographic printing, which usually occurs in blends and vignettes. Also saves time in prepress because it does not require applying bump curves during the platemaking process (Creo Inc., 2005).

As mentioned before ,in AM halftoning the dot size is varied depending on the gray level value of the underlying gray scale image while the dot frequency is held constant but FM halftones have a fixed dot size and shape, but the frequency of the dots varies with the gray level of the underlying gray scale image (Damera, et al 2001).

Objective

This study aims to investigate the effect of FM-AM hybrid and AM screenings on printing quality of flexography printing particularly in highlights areas and image details.

Methodology

This study employed the proper experimental method to determine the impact of FM-AM hybrid and AM screenings on printing quality. The experimental design employed experimental confirmation to investigate differences in the print features of flexographic printing on PE using different screening techniques. The dependent variables were printed dot areas, print contrast, the quality of continuous gradient and the printed details of highlights areas. The measured data was recorded and organized so as to facilitate subsequent analysis.

Materials and Procedures

The digital test form in this research was designed on Illustrator software, it was composed of tonal strips consisted of patches at coverages of 1%-100% and comprised on continuous tone gradient from 1-100%. The test form also contained of two circles filled halftone gradient from 1-10%; one from the center to outside the circle and the other one from outside to the center. Finally the test form contained three images have variety of tones.

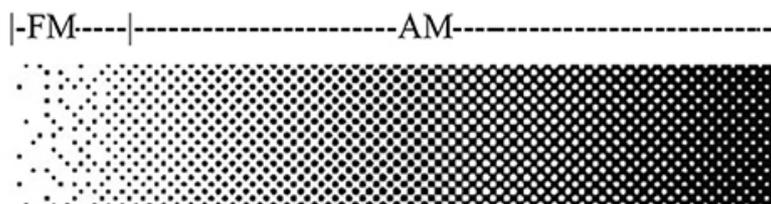


Figure 2: FM/AM Hybrid screening

The test form was generated in two screening techniques, the flexible FM/AM hybrid screening Technology (Kodak/ Maxtone) used in this research employs a random distribution of dots that FM dots were used for highlights areas from 1-6% and the halftones areas from 7-99% were employed AM dots. On the other hand the second screening technique is AM screening for all dots and halftoning areas from 1-99%.

The test form was printed out via flexographic process, the output plate was one color (cyan) at 37.5 screen angle. CTP plate with 100 lpi in terms of resolution, ACT digital from Flint group (1.14

mm - hardness 62shore) was used. The adhesive tape of plate from Tesa, its thickness 0.50 mm and medium soft type. The test form was printed on OMET-X-FLEX flexographic Printing machine. The printing speed was 80 m/min with ceramic protect anilox roll 500 l/cm, cell depth 8 micron, cell volume $1.6 \text{ cm}^3/\text{m}^2$ -1.0 BCM. The type of ink is UV ink, process Cyan HC(High Concentration), its viscosity $21 \text{ mm}^2/\text{s}(40\text{c})$. All tests were performed on PE white $82\text{g}/\text{m}^2$. After printing the results were evaluated and analyzed using X-Rite densitometer and digital microscope.



Figure 3: Test form

Results and discussion

A graph showing the variation of measured dot area with nominal coverage and printed dot area for FM-AM hybrid and AM screenings is shown in figure 4 to quantify the dot gain.

There is dot gain for all dot areas with both screening techniques, the dot gain increases with FM-AM hybrid screening from 7-90% dot areas more than AM screening because of the bump up curve used with AM screening when preparing the digital test form which reducing printed dot gain, on the other hand no bump up curve is used with

FM-AM hybrid screening which explains why increasing dot gain. In highlight areas 1-6%, the resulting dot gain is higher with AM screening than FM-AM hybrid therefore considered an advantage of processing highlight areas. Figure 5 shows the distribution of dots on digital file of highlight areas 1-6% for FM-AM hybrid (a) and AM screenings that there is a random distribution of dots with FM-AM hybrid screening but with AM screening the distribution is regular. It's clear to see the differences in dots combination and distribution in digital file between FM-AM hybrid and AM screenings in figure 6.

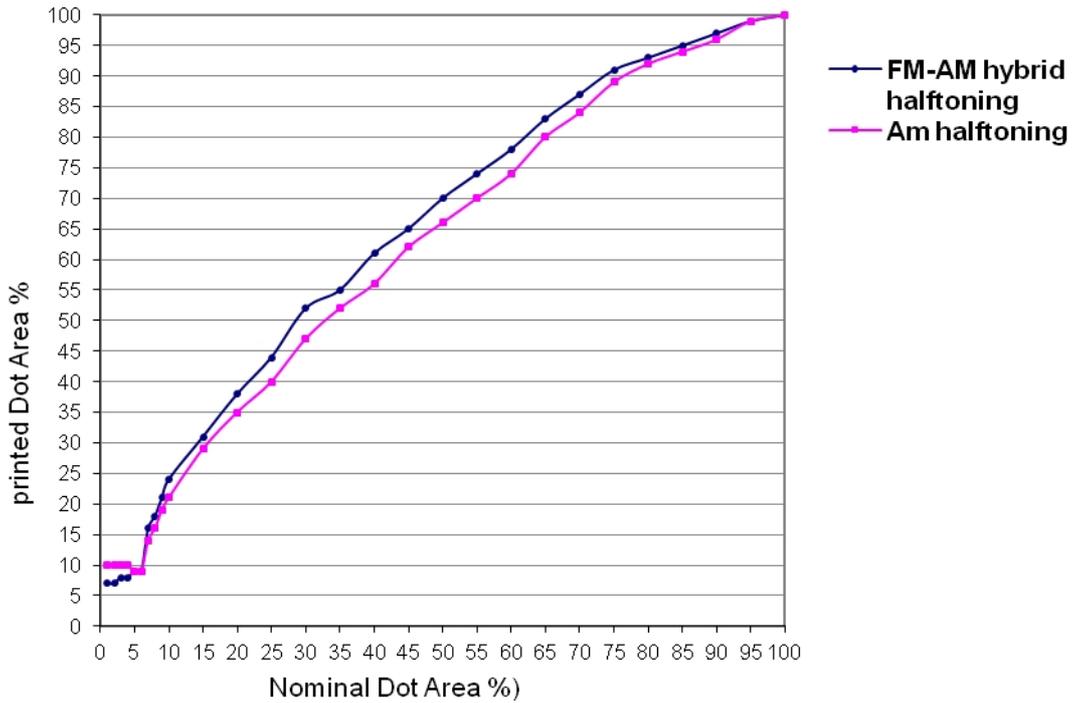


Figure 4: Comparison between printed dot areas for FM-AM hybrid and AM screenings

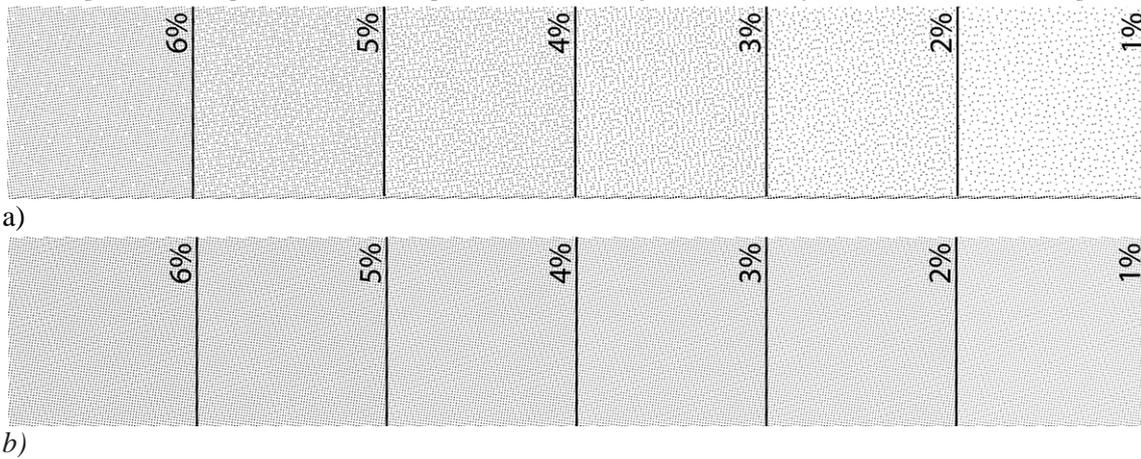


Figure 5: Enlarged image showing a comparison between highlight areas 1-6% on digital file for FM-AM hybrid (a) and AM screenings (b)

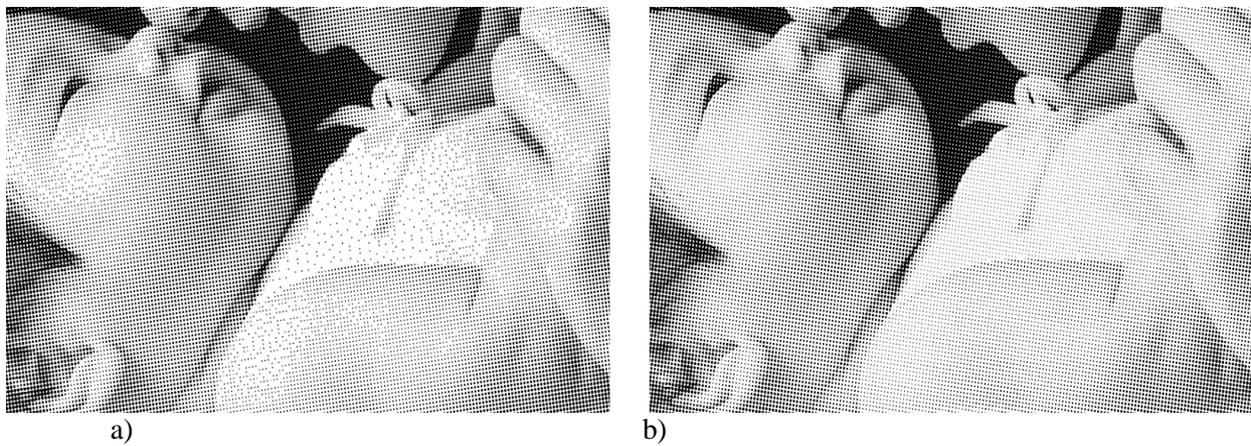


Figure 6: Enlarged images show the differences in dots between FM-AM hybrid screening(a) and AM screening (b)

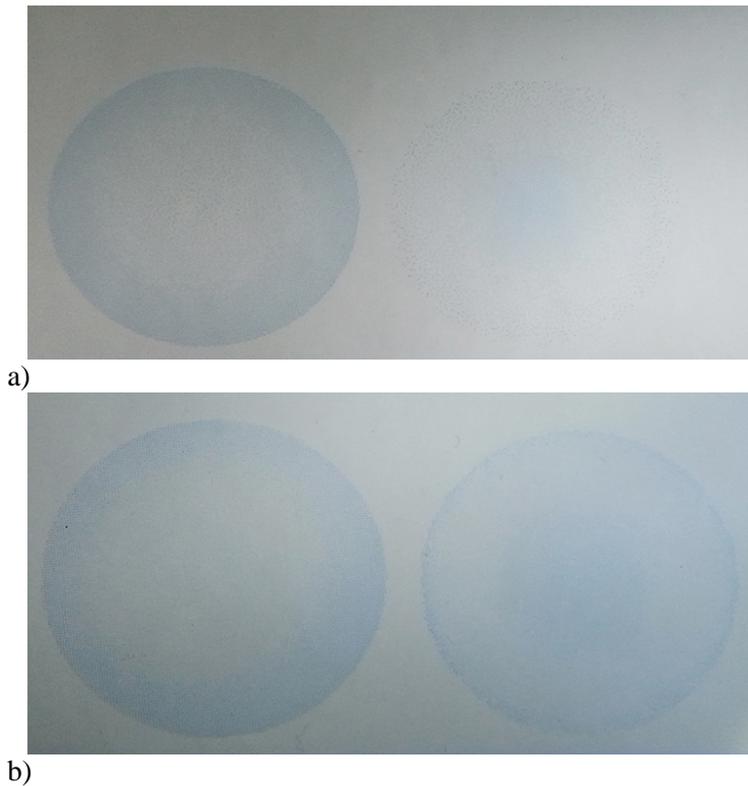


Figure 7: Gradient circles from 1-10% with FM-AM hybrid screening(a) and AM screening (b)

When investigating the printed test form in gradient circles and continuous gradient, the gradients are very smooth and finished until 0% with FM-AM hybrid unlike the gradients with AM screening which show a contour around the circle and not smooth and highlight breaks see figures 7, 8.

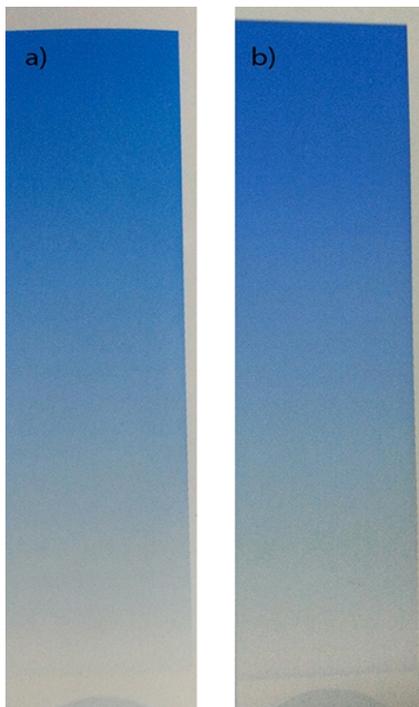


Figure 8: Continuous gradient from 0-100% with FM-AM hybrid screening(a) and AM screening (b)

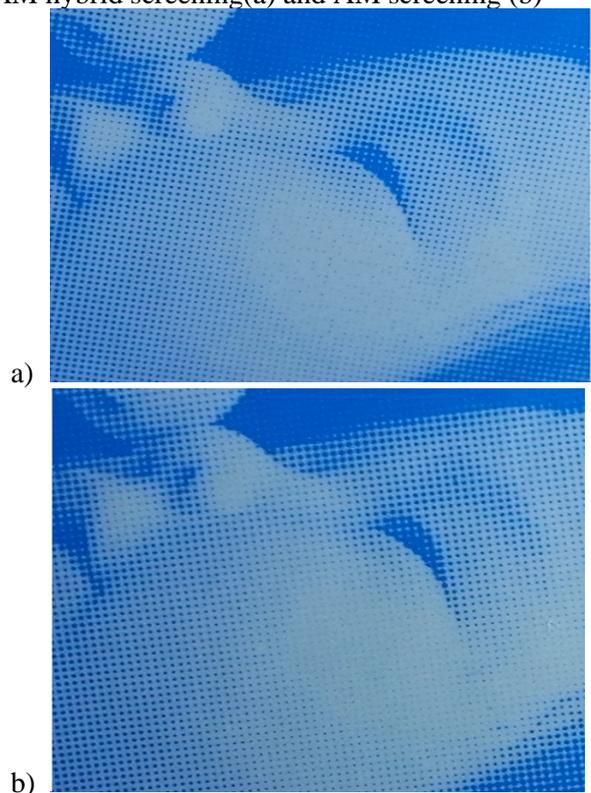


Figure 9: Enlarging images to same section with FM-AM hybrid screening(a) and AM screening (b)

While comparing the printed images details with both screenings in highlights areas, highlight breaks are happened and fine details are lost with AM screening. On the other hand the FM-AM

hybrid screening has random distribution of dots and smooth transition from inked to non-inked areas and from FM highlight areas to the rest of areas produced by AM screening, so the quality of details is better than AM screening technique see figure 9.

According to contrast measurement, the higher contrast of printed color is 53.5% with AM screening more than the contrast that indicates 49.6% with FM-AM hybrid screening, this is due to the lower dot gain resulting with AM screening.

Conclusion

This study aimed to investigate the effect of FM-AM hybrid and AM screenings on printing quality of flexography printing particularly in highlights areas and image details to encourage the Egyptian flexographic originations to benefit the advantages of new screening technology.

As result of the investigation, the following conclusions have been drawn:

- Using FM-AM hybrid screening technology adds solutions to improve image detail, smoother gradients and allows highlights to be reproduced more faithfully.
- The problem resulting from FM-AM hybrid screening is high dot gain compared with AM screening because of no need to apply bump up curve.
- It is very important for pre-press operators to try to make combinations between FM dots for highlight areas and shadow areas and AM dots for intermediate areas to define the best combination to get more effective results for printing quality.
- It must specify a minimum dot size that can be printed to avoid the problems during the production.
- It is hoped that the results of this study can help Egyptian flexography printers to better understand the characteristics of various screening techniques, allowing them to improve printing quality and achieve the highest customer satisfaction.

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