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Comparative Study of Print Contrast on Coated and Uncoated Paper using Amplitude Modulated, Frequency Modulated, Hybrid Modulated and Digitally Modulated Screening in Offset Printing Process

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Abstract— ***This research is an experimental study. The purpose of this research was to determine the significant differences that exist in print contrast of AM vs. FM vs. XM vs. DM screening of multicolour offset printing process on coated and uncoated paper. Print Contrast is the ability of printing press to hold shadow details. Print quality increases with increase of print contrast. Print Contrast is determined by particularly checking the screen in the three-quarter tone. The experiment was conducted using FOGRA 39/ PSO standard. The master/plates of 44.5×29.5 cm output was prepared by incorporating quality measuring parameters and printed in KCMY colour sequence on coated and uncoated paper on 'RYOBI 524HX (Sheet fed Offset) by using different screening technologies. During test, around 150 sheets of each paper were printed to achieve target Solid Ink Density value (± 0.05). Once the density values were achieved according to standard SID values, another 50 sheets were printed for spectrophotometer analysis. Solid Ink Density patches were not compared, as one could expect similar result from all screening technologies. The finding of this research work comparing print contrast of AM vs. FM vs. XM vs. DM screening led to the conclusion that DM screening showed maximum print contrast on coated and uncoated paper among all screening technologies (AM, FM, XM and DM).***

Keywords: Amplitude Modulation Screening (AM), Digitally Modulated Screening (DM), Frequency Modulated Screening (FM), Hybrid Modulated Screening (XM).

I. INTRODUCTION

Screening Technology is used to convert continuous tones images in printing dots [1]. Printing is done by transferring these dots to the desired substrate under defined printing conditions. Print Contrast is the ability of printing press to hold shadow detail. The print contrast is inversely proportional to the dot gain. Print quality increases with increase of contrast [2]. Print Contrast is determined by particularly checking the screen in the three-quarter tone. Print Contrast should have higher value as much as possible. It means that the solids should have a high ink density, but the screen should still print open. When inking is increased and the ink density of the dots is higher, the Print Contrast is increased. However, the increase in ink feed is only practicable up to a certain limit. Above that limit the dots tend to exhibit gain and especially in three-quarter tone, to fill in. This reduces the portion of paper white, and print contrast will decrease. If the solid ink density is correct, the contrast value can be used to assess various factors which influence the print result such as rolling and printing pressure, blankets and underlays, dampening, printing inks and additives. Since the print contrast value, unlike the dot gain, depends to a large extent on the solid ink density it is not suitable as a variable for standardization [3].

There are number of screening methods e.g., Amplitude Modulated (AM), Frequency Modulated (FM), Hybrid Modulated (XM) and Digitally Modulated (DM) Screening used in offset printing processes with pros and cons in each. Latest technologies are replacing the earlier technology to overcome their limitations. Printer has to struggle with a number of problems like misregistration, color shift, ink transfer, clogging of shadow details and moire pattern etc. The Purpose of this research work is to find out suitable screening technology for achieving maximum shadow detailing on gloss coated and uncoated substrates. An experimental approach was adopted for collecting data of print contrast using AM, FM, XM and DM technologies on gloss coated and uncoated white substrates and then making a comparison between them according to achieved print quality to analyse the results.

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II. RESEARCH OBJECTIVE

The research objective of this experiment is to compare the print contrast achieved by using different screening techniques in offset printing process.. An experimental approach is adopted for collecting data of print contrast using AM, FM, XM and DM screening technologies on gloss coated and uncoated white paper and then making comparison between them according to achieved printing quality and analyzes the results.

III. MATERIALS AND METHODS

3.1 Disclosure Materials

In this research work, printing substrates were selected according to the paper types defined by ISO 12647-2 for Offset Printing [3]. The grammage margin of ± 5 is made as per the availability of paper stock in the market. The detail of paper grades used for this research work by the offset Printing Process is summarized in Table 1

Table 1. Specifications of Gloss Coated Paper and Uncoated White Paper

Paper Type	GSM	l	a	b	Company
Gloss Coated	120 g/m2	95.24	0.44	-3.18	SAPPI
Uncoated White	120 g/m2	93.89	2.09	-5.72	ITC

3.2 Four colour Digital Test Chart:

A test chart was made incorporating a number of measuring parameters to evaluate print samples quality. It consisted of GMG strip, Solid bars, Halftone strips, Color registration strip, solid triangles, Slur Target, Star Target, Cross Registration Marks, Reverse text, QR code and some photographs for visual inspection. The special feature of the test chart was GMG unified wedge FOGRA39 v1.0 strip. This FOGRA strip was used for process control in pre-press and printing to ensure high quality output and was patented by Thomson Press.

3.3 Experimental Method

It was an experimental study conducted at Thomson Press Ltd., Faridabad. The printing plates of 44.5×29.5 cm output was prepared by incorporating quality-measuring parameters. Printing was done in KCMY color sequence on gloss coated and uncoated substrates using four different screening technologies (AM, FM, XM and DM) on sheet fed offset press (RYOBI 524HX). During printing, around 150 sheets of each were printed to achieve target solid ink density (C-1.45, M-1.4, Y-1.3 and K-1.75) with tolerance of ± 0.05. Once the solid ink density was achieved according to standard values, another 50 sheets were printed for spectrophotometer analysis. The Print experiment was carried out under the standardized pre-press and press condition using AM, FM, XM and DM screening. For this research work, Print Contrast of C, M, Y and K at 75% patch were measured and analyzed for finding the results.

All printed sheets were allowed to dry for 24 hours and measurements were made using Spectrophotometer (X-Rite Pantone eXact™) instrument. The spectrophotometer is lightweight and portable, handheld tool for measuring color data on a variety of surface. X-Rite Pantone eXact™ spectrophotometer ensures accurate printing of both CMYK and spot colors as well as leveraging industry standard for process control. All printing parameters and conditions were maintained in compliance with ISO specifications during the research work. Table-2 presents the variables, materials, conditions, and equipment associated with press/printing part of this experiment.

Table 2. Prepress: Experimental and Controlled Variable

Designing	i10
Ink	Siegwerk (Process Ink C, M, Y & K)
Ink Sequence	KCMY
Thermal Plate	Elite +ve working
Plate Thickness	0.28mm
Plate size	510mm X 410mm
Developer	THD300
Gum	RC795
CTP	Amsky AURORA T800+
Printing Machine	Ryobi 524HX (Sheetfed Offset)
Printing Speed	8000 IPH
Room Temperature	25-26 ºC
Relative Humidity	50-52 percent
PH of Dampening Solution	5.5
Colour Measurement	Spectrophotometer (X-Rite eXact™)

IV. RESULTS AND DISCUSSION

The findings of the study were based on the analysis of data. The findings represent the specific printing and testing conditions. All the screening technologies (AM, FM, XM, and DM), paper, ink, and dampening solution are important factors to consider for the evaluation of result. The finding of this research may be useful for the printers for the appropriate selection of different screening technologies according to the job. The findings of this research concluded that DM screens were very easy to handle on press. The DM screening analyzed each pixel to ensure that no dot was too small to handle on the plate as well as on press. The printers were able to print all the details without any noise and grains. The shadow tones were open and had excellent print contrast. It controlled consistent dots throughout the run. DM screening was the only screening that could be applicable on any job. With DMS screening, the future of offset printers now looks brighter than ever.

V. CONCLUSION

The conclusions of this study are based upon an analysis of the data. The findings of this study represent specific printing

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conditions. The screening technologies, Paper, ink, film, Dampening solution, imaging system and printing press that were used are important factors to consider when evaluating the results.

Table 3. Comparison of mean scores (AMS, FMS, XMS, and DMS) of CMYK Print Contrast at 75% dot area of Gloss Coated Paper

Process Ink	AMS(M%)	FMS(M%)	XMS(M%)	DMS(M%)
Cyan	47.98	50.88	53.66	59.70
Magenta	50.00	54.02	53.62	61.42
Yellow	41.84	42.12	47.56	59.06
Black	51.36	51.62	59.50	62.28

Table 4. Comparison of mean scores (AMS, FMS, XMS, and DMS) of CMYK Print Contrast at 75% dot area of Uncoated White Paper

Process Ink	AMS(M%)	FMS(M%)	XMS(M%)	DMS(M%)
Cyan	29.38	32.02	35.96	54.38
Magenta	36.04	39.28	39.66	52.86
Yellow	24.78	2708	30.16	48.92
Black	29.58	32.72	39.94	54.62

Print contrast is observed as an integral component in printing to define entire tonal range for image reproduction. This indicates improved ability to reproduce an image with greater shadow details. It is observed that print contrast lowers down as the paper goes coarser. In both paper types (Gloss coated paper, and Uncoated white paper), GC paper showed better print contrast as showed in Table 3 and Table 4. Among all screening technologies (Amplitude Modulated Screening, Frequency Modulated Screening, Hybrid Modulated Screening and Digitally Modulated Screening), DM screening showed maximum print contrast on both coated and uncoated paper. Amplitude Modulated Screening showed minimum print contrast among all screening technologies. It is also observed that Hybrid Modulated Screening is having more print contrast than AM and FM screening. Figure 1 presents press print sheets by AM, FM, XM and DM Screening.

Figure1. AM, FM, XM and DM Printed Press Sheets

Printed Sheets by AMS, FMS, XMS and DMS

From a practical standpoint, Auraia DMS combined the greatest features of AM, FM, and XM screening procedures with the ground-breaking patented technology to create a unique product. Auraia DMS improved quality, stability, and gamut while saving ink compared to the traditional screening. Auraia DMS delivered these advantages in real-world production settings, including plate and press circumstances that are not normally conducive to FM or high-lpi AM/XM screening.

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