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Analysis of Print Mottle in Sheet-Fed Offset and Digital Printing

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***Abstract*— Print mottle is the non uniform appearance in solid tone area with sufficient ink covering while printing. This is most harmful features of print quality resulting in the unintentional spatial reflectance variations on to the substrate. Print quality has been an important aspect of printing. In recent age of science, the most dominating printing processes used worldwide are offset and digital printing. This present system is used for analyzing print mottling in sheet-fed offset as well as in digital printing. During research the various printing variables were taken into consideration. The key objective of this paper is to investigate various types of print mottle and major causes influencing occurrence of mottling during printing.**

***Index Terms*— Mottle, Spatial reflectance, Print Quality, Offset Printing, Digital Printing**

I. INTRODUCTION

The quality of a printing is the key concern for every printer at any cost. The quality of print varies due to various reasons or defects which occur while printing. One such major defect is print mottle. Print mottling is a common defect in printing industry. It is basically a non uniform appearance of paper surface with sufficient ink covering. The print mottle does not occur not only in the solid printing on commercial paper but also it appears on the half tone dots. And there are some more reasons for it to appear other than those related to ink transfer. Print mottle can occur on all types of printing surfaces, whether it is porous like paper or non porous like plastic surfaces. Print mottle can occur in different printing processes but the tendency of occurrence varies. It appears in many forms and in various scales. It can appear in random patterns like clouds or in systematic patterns like strips or repetitive patterns. Random patterns can be of large size like cloudiness or of small size like graininess. At any level of magnification, the degree of mottle is determined by the spatial distribution of the transitions from one luminance level to another or texture distribution variations.

In offset printing, print mottle is caused due to irregular back trap of ink which happens due to irregular rate of drying. It is called as back trap mottle. It also occurs due to non uniform absorption of fountain solution on the surface of paper. Ink and water uneven balance is major reason for various type of mottling. On the other hand in digital printing this problem is eliminated. But calibration during printing and ink toner influence print mottling.

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Objectives of Study

The key objectives of this research are to elucidate on the following aspects of print mottle in Sheet-fed Offset and Digital printing: -

i. To analyse print mottle in Sheet-fed Offset Printing
ii. To analyse print mottle in Digital Printing
iii. Comparative analysis between Sheet-fed Offset and Digital Printing
iv. Finding out various causes and remedies of print mottle in Sheet-fed Offset and Digital Printing.

II. RESEARCH METHODOLOGY

In order to analyze the print mottle in sheet-fed offset and digital printing, this research work was carried. Sheet-fed offset and digital printing jobs were analyzed for mottle. To analyze the research work and finding the results, a magnifying glass was used. Magnifying glass helps in identifying the type of print mottle defect occurred in offset and digital printing. The whole research was based on observation and identification of mottle defects being occurred in Sheet-Fed offset and Digital printing. In this research work, the perceptive evaluation by several standard observers i.e. the difference of print mottle level between various jobs was observed. A Munsell cell test was conducted on the observers. Those who pass the test were considered as the standard observer. A Munsell test is a color vision test often done to check the color blindness of the person. It tests the ability of a person to know various color targets with constant value and chrome that cover all the visual hues described by the Munsell color system. Color vision accuracy is basically important for designers, photographers, printers and colorists who all rely on accurate color vision to produce quality content.

Data Analysis

The data was collected during research. The data so collected was compiled and analyzed in order to accomplish the research effectively. By using this statistical data, the interpreted results were expressed in graph and figure. The following aspects were taken into consideration during analysis:-

1. Analysis of Print Mottle in Sheet fed Offset Printing
2. Analysis of Print Mottle in Digital Printing
3. Comparative analysis between Sheet-fed Offset and Digital Printing
4. Finding out various causes and remedies of print mottle.

These various aspect from research point of view are illustrates as below: -

1. Analysis of Print Mottle in Sheet-fed Offset Printing: - "Oil and water do not mix with each other," this is the principle on which Offset Printing underlies. Depending upon the nature of printing process the various types of print mottles are predictable which are enlisted as below:

A. Printer's Mottle
B. Ink Trap Mottle
C. Back Trap Mottle
D. Water Interface Mottle

The results of the data collected during the research are depicted in fig.1. It was found that the maximum frequency of mottling occurrence was 34% i.e. printer's mottle. In addition to this there is 30% probability of water interface mottling occurrence. On the other hand ink trap mottling frequency was found minimum i.e. 17%.

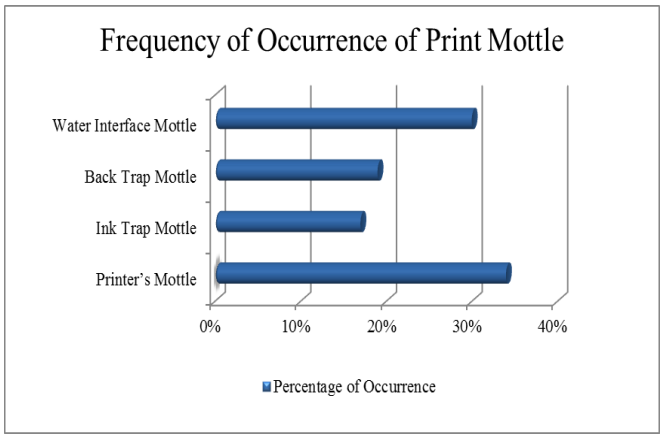

Fig. 1: - Frequency of Occurrence of various type of print mottle in Sheet-fed Offset Printing

A. Printer's Mottle: - Printer's mottle is most common type of mottling which often occurs due to the misconfigurtion of the press with non uniform ink film on the paper. The results of the present investigation are presented in fig. 2.

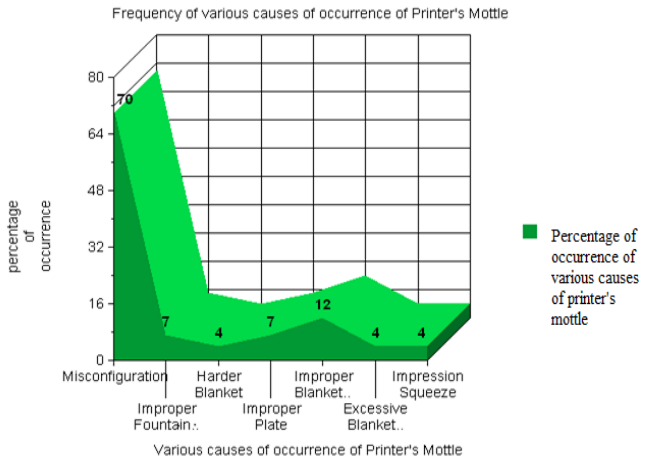

Fig. 2.:- Frequency of various causes of occurrence of Printer's Mottle

The data expressed in fig. 2 depicts that the major reason for printer's mottling occurrence is misconfigurtion of the machine which we use while printing. Due to misconfigurtion of machine 70% mottling results while another cause printer's mottling is improper blanket used in sheet-fed offset machine while printing.

B. Ink Trap Mottle: - When paper passes from unit to unit in multicolour printing, poor or inconsistent ink trap transfers non uniform ink film on the paper or the previous ink film printed, such type of defect is known as Ink Trap Mottle.

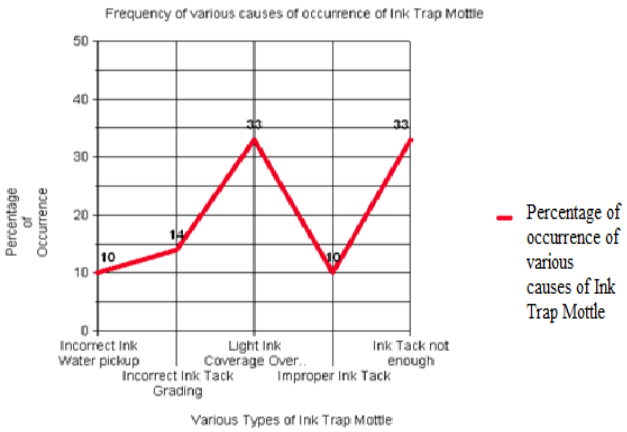

Fig. 3. : - Frequency of Occurrence of various causes of occurrence of Ink Trap Mottle

The result presented in fig. 3 depicts that Ink Trap mottling is the consequence of both insufficient ink tackiness and light ink coverage print over heavy ink coverage. Another key factor includes incorrect ink-water pick up, incorrect grading of ink tack and improper ink tack.

C. Back Trap Mottle: - When the printed sheet travels from one unit to another, the ink film on the paper surface traps back non-uniformly onto subsequent blankets doing uneven ink transfer and absorption on the paper surface. This defect is known as back trap mottling.

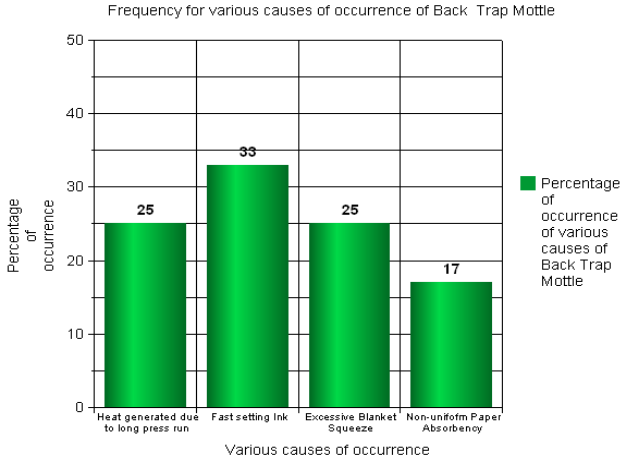

Fig. 4. : - Frequency of Occurrence of various causes of occurrence of Back Trap Mottle

The result of the observations of back trap mottling are presented in fig. 4 which depicts that back trap mottling have maximum frequency of 33% when we use fast setting ink during offset printing. It is also the consequence of excessive

blanket squeeze and heat generation due to long press run. Also non uniform paper absorbency plays a crucial role while occurrences of back trap mottle.

D. Water Interface Mottle: - Due to ink and water imbalance, it results in the blur and low dot structure in subsequent units of printing especially when paper absorbs fountain solution unevenly and hence ink applied in the subsequent units lay unevenly. This defect is known as water interference mottle.

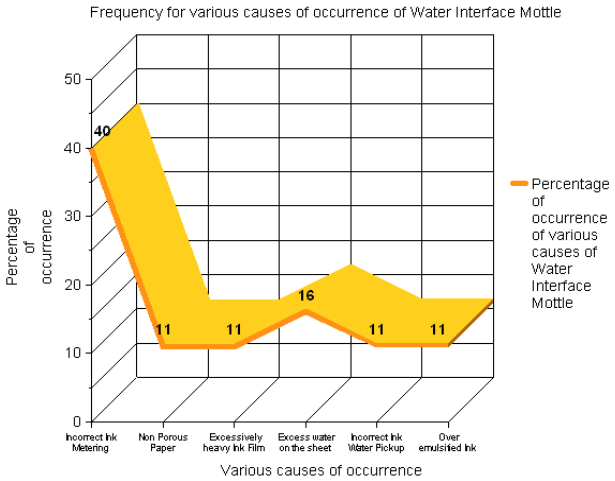

Fig. 5. : - Frequency of Occurrence of various causes of occurrence of Water Interface Mottle

The results of the data collected during the research are depicted in fig. 5. During investigation it was found that the maximum frequency of water interface mottling is the result of ink and water imbalance on to the substrate during printing. The maximum frequency of water interface mottling occurrence was found 40% i.e. incorrect ink metering. In addition to this there is 16% frequency of excess water occurrence on the sheet surface during water interface mottling. On the other hand non porous paper, excessively heavy ink film, incorrect ink and water metering and over emulsified ink also contribute to some extent.

2. Analysis of Print Mottle in Digital Printing: - Digital printing is a method of printing by which a digital image is directly printed on a variety of substrates. Depending upon the nature of printing process the various types of print mottles are predictable which are enlisted as below: -

A. Back Trap Mottle
B. Ink Trap Mottle

The results of the data collected during the research are depicted in fig. 6. It was found that the maximum frequency of mottling occurrence was 10% for Ink Trap and Back Trap mottling. On the other hand frequency of Printer's mottling and Water Interface mottling occurrence was found nil reason being there is no need of water-ink balance during digital printing. Also there is no question arises on the misconfigurtion of the press in digital printing which leads to the occurrence of Printer's mottle.

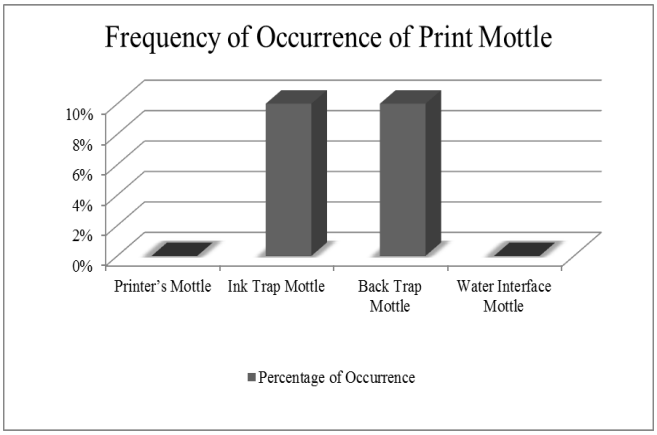

Fig. 6. : - Frequency of Occurrence of various types of Print Mottle in Digital Printing

A. Back Trap Mottle: - In similar way discussed above back trap mottling occurs due to the ink film on the paper surface traps back non-uniformly onto subsequent blankets doing uneven ink transfer and absorption on the paper surface when the printed sheet passes from unit to unit in multicolour printing.

Causes and Remedies: - The major cause of occurrence of this type of mottle is that the press was not calibrated. To remove these defects calibrate the machine regularly.

B. Ink Trap Mottle: - As discussed above that Ink Trap Mottle is resulting poor or inconsistent ink trap transfers non uniform ink film on the paper or the previous ink film printed when paper passes from one unit to another multicolour printing.

Causes and Remedies: - The major cause of occurrence of this type of mottle is not proper fusion of toner on the substrate. This can be removed by fusing the toner properly.

3. Comparative analysis between Sheet-fed Offset and Digital Printing:

As Sheet-fed offset and digital printing both are most dominating printing processes in this modern era. Therefore comparative study between these two printing processes becomes inevitable. During the research the results of the data collected for sheet-fed offset and digital printing are depicted in fig.1 and fig. 6 respectively. In sheet-fed offset printing, it was found that the maximum frequency of mottling occurrence was 34% i.e. printer's mottle. Conversely in case of digital printing printer's mottle occurrence frequency is almost zero. In addition to this there is 30% probability of water interface mottling occurrence, but in case of digital printing there is completely absence of fountain solution. On the other hand ink trap mottling frequency occurrence in offset and digital printing was found 17% and 10% respectively.

4. Finding out various causes and remedies of print mottle:-

The various aspects responsible for occurrence of mottling have been taken into consideration while carrying out the research. Now some of them are enlisted here below: -

SHEET-FED OFFSET PRINTING		
TYPES OF MOTTLING	**CAUSES**	**REMEDIES**
Printer's Mottle	Misconfigurtion of the press	Configure the press properly
	Improper fountain conductivity	Maintain conductivity of fountain
	Harder blanket	Use softer blanket
	Excessive blanket pressure	Reduce the blanket pressure
Ink Trap Mottle	Incorrect ink water pickup	Correct ink water pickup
	Incorrect ink tack grading	Correct the ink tack grading
	Improper ink tack	Maintain ink tack
Back Trap Mottle	Heat generated due to long press run	Installation the exhaust fan
	Excessive Blanket squeeze	Reduce the blanket squeeze
Water Interface Mottle	Incorrect Ink Metering	Check the inking rollers
	Excess water on the sheet surface	Check dampening system
	Incorrect Ink and Water Metering	Check inking and dampening unit
	Over Emulsified Ink	Add reducers to the ink
DIGITAL PRINTING		
Ink Trap Mottle	Toner not fused properly	Fuse toner properly
Back Trap Mottle	Machine not calibrated	Calibrate the machine regularly

III. Results and Discussion

The data was collected and analyzed. During the analysis it was found that while printing either sheet-fed offset or digital printing, print mottling is the most common and frequently occurring printing defect. It was observed that the results obtained during the research were in accordance with the print quality standard range. The overall result observed was that in case of digital printing there is limited range of occurrence of mottling defect. On the other hand in case of sheet-fed offset printing, due to the nature of printing principle the frequency of occurring of mottling is wide. The summary of the frequency of occurrence of mottling in Sheet-fed Offset and Digital Printing is enlisted in table 1 as below: -

Type of Print Mottling	**Sheet-fed Offset Printing**	**Digital Printing**
	Percentage of Occurrence	
Printer's Mottle	34%	0%
Ink Trap Mottle	17%	10%
Back Trap Mottle	19%	10%
Water Interface Mottle	30%	0%

Table 1: - Summary of the frequency of occurrence of mottling in Sheet-fed Offset and Digital Printing.

IV. Conclusion

This research paper has presented an overview about the analysis of print mottle and different aspects of print mottle in Sheet-fed Offset and Digital printing. Print mottle in one of the most common printing defect that occurs while printing. Depending upon the nature of printing process the various types of print mottles are predictable. On the bases of the analyzed data, this research paper reflects that the most prominent type of mottling in sheet-fed offset printing is the printer's mottling having a frequency of occurrence of 34%. The second most common type of print mottle is Water Interface Mottle having a frequency of occurrence of 30%. This defect mostly occurs due to inconsistency in metering of fountain solution during offset printing. On the other hand Ink Trap and Back Trap mottling are the types of mottling which are common in both sheet-fed offset and digital printing. In case of offset printing there are more chances of occurrence of mottling. The principle of offset printing "Ink and Water balance" i.e. Chemical separation of image and non-image area is responsible for this frequency was found minimum i.e. 17%. In contrast to offset printing, this research paper reveals that occurrence of mottling defect cannot be eliminated completely in digital printing also. But its occurrence frequency is limited comparatively to that of offset printing.

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