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A Study of the Ink Trapping in Lithographic Printing

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ABSTRACT

The effects of paper structures and ink trapping conditions on the ink trapping were investigated for a commercial lithographic printing system. The ink trapping is estimated optically with the use of densities. The results indicate that papers with coating structures allow much better ink trapping than uncoated papers. The ink trapping coefficients of different overprints on coated papers are 1.7 times higher than that on uncoated papers. The ink trapping at wet-on-dry overprints is more effective and insignificantly depends on the paper structure.

Keywords: Lithographic Printing, Ink Trapping, Wet-On-Wet, Wet-On-Dry, Paper Absorption

I. INTRODUCTION

Ink trapping is defined as the amount of the second ink transferred on top of the first ink during the multi-colour printing process [1].In the printing process of pasty inks, such as lithography, the upper ink layers are never trapped with the whole layer thickness compared to printed directly on paper. Hence, the ink trapping is evaluated or measured in terms of percentage. A high percentage is "good" because it gives the desired colour. A low percentage, which gives uneven or off colour, is "poor". A poor percentage narrows the printable colour gamut and may cause image problems [2].

A high percentage of trapping requires the right balance of three factors: Tack, Absorption, and Time. Tack is primarily a matter of ink. Absorption depends on the paper. Time is press-related. By understanding the effects of each, you will be able to make decisions that can help assure more satisfactory printing results [2].

Tack is the "stickiness" of ink, which can range in consistency from molasses to soft butter. Tack measures the force needed to split an ink film between two rotating rollers at a predetermined speed and temperature. Tack is a significant factor that enables inks to adhere to or trap one another; tack sequence allows us to control and achieve quality trapping [3, 4].

In the proper sequence, the first ink down must have the highest tack, and subsequent inks have lower effective tacks.

It is known that trapping often requires solvents to be absorbed from the ink so that it can build tack. This absorption depends on the surface and structure of the paper - the more absorbent the paper, the greater the increase in tack. However, for a good ink transfer, the balance between ink hold-out on the surface and absorption through the pores needs to achieve. Recognition of this interaction enables the printer to make proper ink adjustments.

In multi-colour lithographic printing, ink transfer from the first printing unit on to substrate is wet-on-dry. Subsequent printing units print wet-on-wet on the already printed area. Chung et al. imply a significant difference between 'wet-on-dry' and 'wet-on-wet' density-base ink trapping values.

In our study, the effect of paper structure on the ink trapping was investigated for two ink transfer conditions: 'wet-on-dry' and 'wet-on-wet'. A commercially available ink set and a multi-colour litho-offset press were used.

II. METHODS AND MATERIAL

A. Experiment

The experiment was carried out in CTP workflow. The test form Altona Test suit 1.1 (Fig. 1) was output by using AM technology with a resolution of 175lpi. Heidelberg SM 74-2 colours printing machine, as shown in Fig. 2

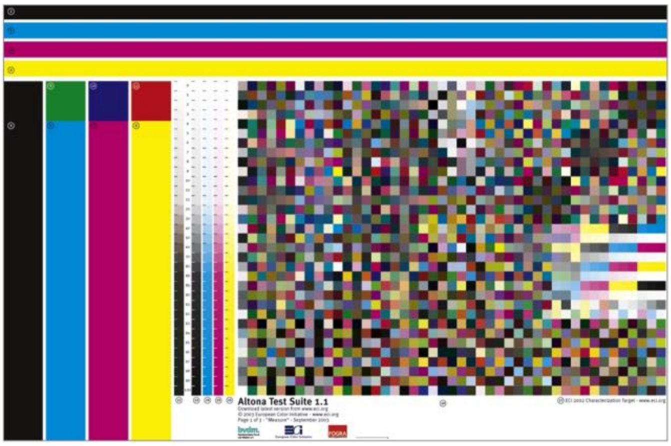

Figure 1: The CMYK test target

Figure 2: Offset printing machine SM74 – 2012

Offset printing inks Nippon speed (Cyan - C, Magenta - M, Yellow – Y) and two types of paper: Coated paper 150 g/m^2 and Uncoated paper 150 g/m^2 were used. Tack values of C, M, and Y inks are consequently 13.8, 13.4, and 12.8.

The printing process was carried out with the ink tack sequence Cyan – Magenta – Yellow and a speed of 10.000 sph.

B. Ink trapping measurement

The ink trapping was calculated between the density of the first and second colour sequence and the trapping of overlap two colours in wet-on-wet ink transfer as the formulas of Preucil [5]

$$FA(\%) = \frac{D_{12} - D_1}{D_2} \qquad (1)$$

Here, D_1 is the solid tone density of the first-down ink; D_2 is the solid tone density of the second-down ink, and D_{12} is the density of the overprint solid.

The dry densities are measured by an X_Rite SpectroDensitometer 504, Inc.Grandville, MI

III. RESULTS AND DISCUSSION

A. Effect of paper structure on the ink trapping

The ink trapping coefficients of C-M and M-Y overprints calculated for coated and uncoated papers are reported in Table 1 and Fig. 3.

TABLE I

INK TRAPPING FA(%) OF TWO INK OVERPRINTS

Sample	D_1	D_2	D_{12}
Coated paper			
C-M overprint			
1	0.51	1.72	1.70
2	0.50	1.74	1.71
3	0.51	1.74	1.70
4	0.51	1.73	1.71
5	0.51	1.74	1.70
Average	0.51	1.73	1.70
FA(%)	69		
M-Y overprint			
1	0.67	1.50	1.64
2	0.68	1.51	1.65
3	0.67	1.51	1.64
4	0.67	1.50	1.65
5	0.68	1.51	1.65
Average	0.67	1.51	1.65
FA(%)	65		
Uncoated paper			
C-M overprint			
1	0.62	1.12	1.10
2	0.62	1.11	1.10
3	0.62	1.12	1.11
4	0.62	1.13	1.11
5	0.62	1.13	1.11
Average	0.62	1.12	1.11
FA(%)	43		
M-Y overprint			
1	0.75	1.08	1.16
2	0.75	1.09	1.16
3	0.76	1.09	1.17
4	0.75	1.08	1.15
5	0.75	1.08	1.15
Average	0.75	1.08	1.16
FA(%)	38		

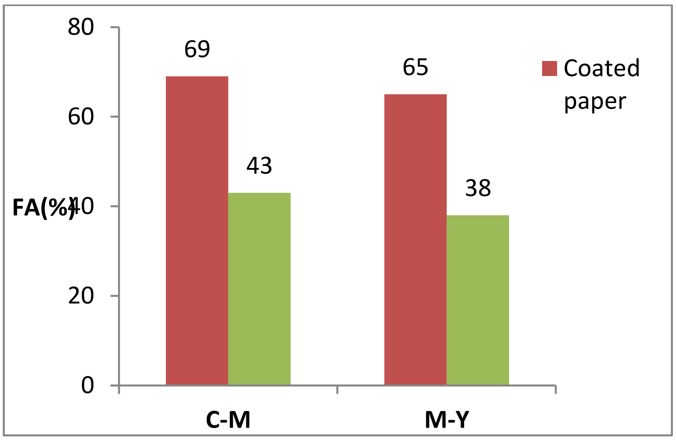

Figure 3: Ink trapping FA (%) of different overprints on two types of paper (ink trapping wet-on-wet)

It can be seen that the ink trapping on the coated paper is significantly higher (about 1.7 times) than that on the uncoated paper. This result can be explained by the significant difference in surface smoothness and absorbency of the two substrates. The uncoated paper has a coarse, porous structure and strongly absorbing ink solvents, so the amount of ink transferred to the paper is significantly more than the ink transferred to the previous ink layer. According to formula (1), the ink transfer coefficient is low. In contrast, the coated paper has less absorbency, and the amount of ink transferred to the paper and the first ink layer is not much different, leading to a high ink transfer coefficient.

Furthermore, the ink layer hold-out on the coated paper surface is more significant, resulting in increased measured colour density value. The question here is whether density-based ink trapping measurements can be inaccurate when assessing the effect of paper because the paper structure affects the light scattering results. However, studies comparing the density-based and weight-based trapping have shown similarities between the two methods with different types of paper [1, 6].

B. Effect of ink trapping condition

In this series of experiments, the ink trapping coefficients of C-M and M-Y overprints on the uncoated paper were investigated at the wet-on-wet and wet-on-dry trapping processes. The results are reported in Table 2 and Fig. 4.

The ink trapping coefficient increases as wet on dry transfer. The ink tack is higher on the top of dry ink. This result is easy to comprehend because the adhesion between the upper and lower ink is more substantial. Similar results were observed for different printing systems [1].

TABLE III

INK TRAPPING FA(%) OF TWO INK OVERPRINTS

Sample	D_1	D_2	D_{12}
C-M overprint			
Wet-on-wet			
1	0.62	1.12	1.10
2	0.62	1.11	1.10
3	0.62	1.12	1.11
4	0.62	1.13	1.11
5	0.62	1.13	1.11
Average	0.62	1.12	1.11
FA(%)	**43**		
Wet-on-dry			
1	0.60	1.07	1.24
2	0.60	1.07	1.23
3	0.61	1.08	1.25
4	0.60	1.07	1.23
5	0.60	1.07	1.24
Average	0.60	1.07	1.24
FA(%)	**60**		
M-Y overprint			
Wet-on-wet			
1	0.75	1.08	1.16
2	0.75	1.09	1.16
3	0.76	1.09	1.17
4	0.75	1.08	1.15
5	0.75	1.08	1.15
Average	0.75	1.08	1.16
FA(%)	**38**		
Wet-on-dry			
1	0.74	1.09	1.20
2	0.74	1.08	1.21
3	0.75	1.09	1.21
4	0.74	1.09	1.21
5	0.74	1.10	1.21
Average	0.74	1.09	1.21
FA(%)	**44**		

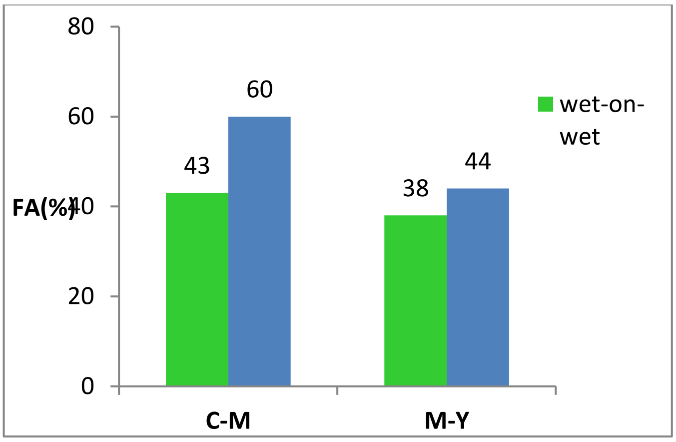

Figure 3: Ink trapping FA (%) of different overprints on two types of trapping (uncoated paper)

IV. CONCLUSION

The effects of paper structures and ink trapping conditions on the ink trapping were investigated for a commercial lithographic printing system. The results indicate that papers with coating structures allow much better ink trapping than uncoated papers. The ink trapping at wet-on-dry overprints is more effective and insignificantly depends on the paper.

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