# INK TRAPPING IN HYBRID PRINTING TECHNOLOGY

Martina Miletic, student
Sonja Jamnicki, PhD student
Irena Bertic, PhD student
University of Zagreb, Faculty of Graphic Arts, Getaldiceva 2, Zagreb, CROATIA
Phone: +38512371080, fax: +38512371077, e-mail: martina.miletic@gmail.com

## ABSTRACT

In this paper the authors have studied the prints made with combination of flexo and offset inks used in hybrid printing technology.

A good image reproduction is determined by appropriate trapping. Poor trapping means that superimposed inks are improperly laid down on the previously printed colours, causing poor colour balance and poor overall appearance.

Hybrid press systems use combination of different printing units, which makes it possible to implement an offset unit in a flexo line.

Each technology has its advantages which, when connected in one production line, can improve the quality of prints and provide the added value of graphic product.

Flexo printing includes low viscosity inks and offset uses paste, viscous inks. According to that rheology and drying characteristics are different for each type of ink.

The aim of this study was to investigate how two different types of inks interact when printed one over the other in different conditions.

The prints for the evaluation of trapping were obtained by applying the flexo ink onto the substrate and then the offset ink onto the layer of flexo ink by means of wet-on-wet overprinting. The flexo ink was applied with the appropriate “K Hand Coater” device and the offset ink was applied with the IGT A2 printability tester, simulating offset printing. Two kinds of paper, offset paper and liner paper, were used as substrates. Trapping of offset ink over the flexo ink was evaluated by its effect onto the final L*a*b* properties of the samples obtained.

## 1. INTRODUCTION

A combination of various printing technologies is very often employed for achieving a graphic product with added value. Technologies that combine different printing techniques in one production line are known as hybrid printing systems. They can be composed of different conventional printing techniques combining offset, flexo or gravure printing units in one printing system. In addition, digital printing units are combined with one of the conventional printing units.[1]

Among the hybrid printing systems that combine the conventional printing techniques, those connecting the offset and flexo printing are mostly used. With the combination of these two techniques it is possible to positively influence the quality of the output graphic product. [2]

In package printing, there is a growing need for special inks and coatings that are not easily printed using the standard offset printing technique. A combination of offset and flexo units in one printing system can be a solution for high quality package and label printing. [3]

Flexo and offset inks greatly differ in their rheological characteristics. Flexo inks are fluid inks and offset inks are more viscous inks and are usually referred to as paste inks. Regarding the different types of the ink used, printing with a hybrid system can be problematic, in particular when overprinting is carried out using different process.

The aim of this study was to investigate how two different types of inks interact when printed one over the other on different types of substrates.

## 2. EXPERIMENTAL METHOD

The prints made by combination of flexo and offset inks were studied in this paper. **Ink trapping value** was the print quality characteristic chosen for the evaluation of hybrid printing technique.

Trapping is defined as the ability (or inability) of the printed ink to adhere to a previously printed ink. [4] Good acceptance of ink on the existing ink depends on rheology (viscosity and tackiness) of the ink which is overprinted, on the ink film thickness and on the printing sequence of the inks. A change in lay down results in a change of the colour value and therefore affects image reproduction accuracy.

The hybrid printing system was simulated by combining laboratory type flexo and offset printing units. Laboratory prints were produced by overprinting a uniform layer of the offset ink on the flexo ink. With this procedure, the secondary colours (blue, green and red) were reproduced and measured.

The prints obtained by overprinting two offset inks, as well as two flexo inks, were used as the reference values (standard prints) for comparison with the hybrid prints.

Besides ink trapping values, **colorimetric measurements** of prints were also preformed and the colour difference ($\Delta E_{ab}$) was determined from the measured L*a*b* values of the studied samples and reference prints.

### 2.1. Measuring methods

Flexo inks were printed using the K Hand Coater device. For the application of the flexo ink, the K Bar number 1 was used. Offset inks were printed using the IGT A2 printability testing device, which simulates an offset printing press. The printing speed was 125 cm/s and the printing force was 350 N. The fountain solution used in the offset printing process was laboratory made.

Immediately after applying the flexo ink onto the substrate, the offset ink was overprinted in order to achieve wet-on-wet acceptance of the ink.

The thickness of a single ink layer was approximately equal. Exactly $1cm^3$ of the offset ink was applied on the IGT inking unit, so that the thickness of the offset ink layer on print was 8 μm. The thickness of the flexo ink layer was 6 μm.

Since the two printing techniques combined in the described hybrid printing system use essentially different printing inks considering their rheology and drying characteristics, the prints were made on two types of the printing substrates. Offset paper and liner paper (regularly used in flexo printing on paper substrates) were chosen as representative printing substrates. The characteristics of the used printing substrates are given in the following tables:

**Table 1. The offset paper characteristics**

| calliper | grammage | absorbence/Cobb 120 | roughness/Bendtsen |
|---|---|---|---|
| 0,117 mm | 90 g $m^{-2}$ | 50 g $m^{-2}$ | 200 ml $min^{-1}$ |

**Table 2. The liner paper characteristics**

| calliper | grammage | absorbence/Cobb 120 | roughness/Bendtsen |
|---|---|---|---|
| 0,180 mm | 140 g $m^{-2}$ | 35 g $m^{-2}$ | 601 ml $min^{-1}$ |

The offset inks used in this study were based on vegetable oil technology and were mineral oil free. The viscosity of the used offset inks was 45-50 Pa s. Offset inks are viscous inks of great tackiness which dry by oxidation and adsorption into the printing substrate.

The flexo inks used in this study were water-based. Those inks are of low viscosity and they almost instantly dry on absorbent printing substrates. The viscosity of the used flexo inks was 40-60 sec F4.

The densitometric and spectrophotometric values were measured on the obtained laboratory prints with the X-Rite Color Digital Swatchbook device.

The values of two-colour trapping were calculated using the Preucil equation from the densitometric values of solid patches of cyan, magenta and yellow and overprinted patches M+Y, C+Y and C+M.

The trapping value (FA) for two-colour overprinting was calculated on the basis of the following equation:

***Equation 1.***

$$FA_{\substack{2\\1}}(\%) = \frac{D_{1+2} - D_1}{D_2} \times 100$$

where:
D1+2 is the ink density of the two overprinted colours,
D1 is the ink density of the colour that was printed first,
D2 is the ink density of the colour that was printed last.

The colorimetric L*a*b* values of prints were determined and the colour difference ($\Delta E_{ab}$) was calculated between hybrid prints and offset and flexo reference prints. The colour difference ($\Delta E_{ab}$) was calculated on the basis of the following equation:

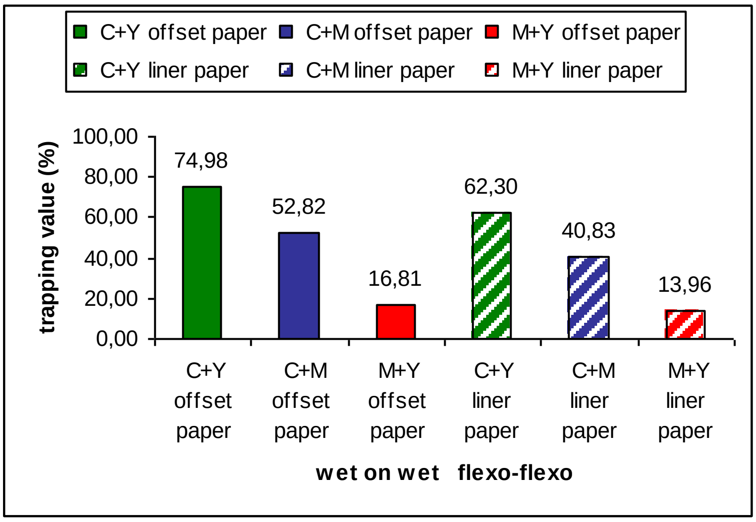
***Equation 2.***

$$\Delta E_{ab} = \sqrt{(\Delta L^2 + \Delta a^2 + \Delta b^2)}$$

For a better presentation of colour difference between the obtained hybrid prints and the reference prints, a* and b* colorimetric values were expressed using the CIE a*b* diagram.

## 3. RESULTS AND DISCUSSION

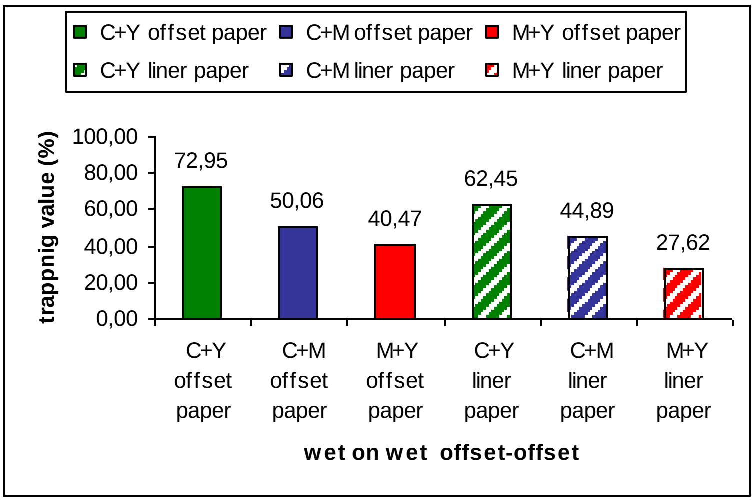
The trapping values, expressed as the arithmetical mean of 10 measurements, are presented in Graphs 1 to 3. The values of trapping for different printing techniques on each graph are presented separately for offset and for liner paper.




***Graph 1***. *Flexo «reference» prints*

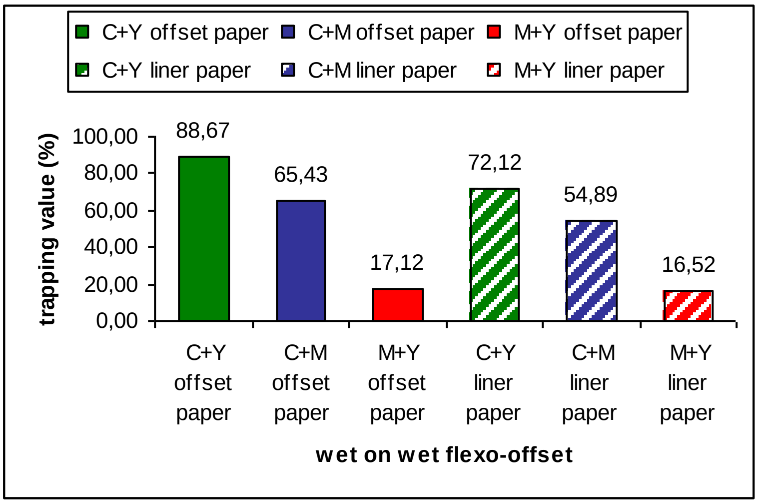
The values of wet-on-wet trapping of the flexo overprints are presented in Graph 1. These results were used as **flexo reference values** for comparison with the hybrid prints.

From measurement results it can be seen that the highest trapping value was measured on the green prints, followed by the blue and red prints respectively. The same trend was seen on both kinds of printing substrates. The values of trapping in this printing system are somewhat higher on the prints obtained on offset paper.




***Graph 2.*** *Offset «reference» prints*

The values of wet-on-wet trapping of the offset overprints are presented in Graph 2. These results were used as **offset reference values** for comparison with the hybrid prints. From measurement results it can be seen that the highest trapping value was achieved on the green prints, followed by the blue and red prints respectively. The offset overprints follow the same trend as the flexo overprints but their trapping values are somewhat lower than of the flexo overprints with exception of the red offset overprints on which higher trapping values were achieved.



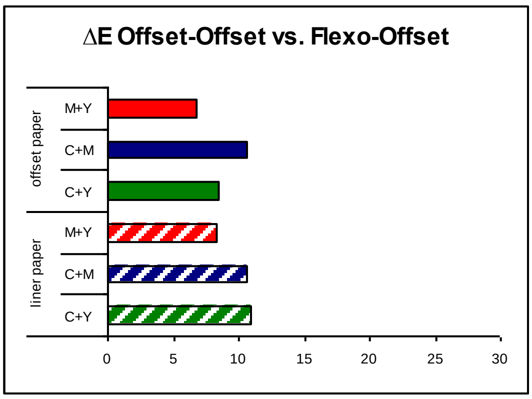

***Graph 3***. *The flexo-offset hybrid prints*

The trapping values of the hybrid printed samples, obtained by overprinting offset on flexo inks, are presented in Graph 3. The measured trapping values follow the same trend as the reference samples trapping results. The highest trapping value was measured on the green prints, followed by the blue and red prints respectively.

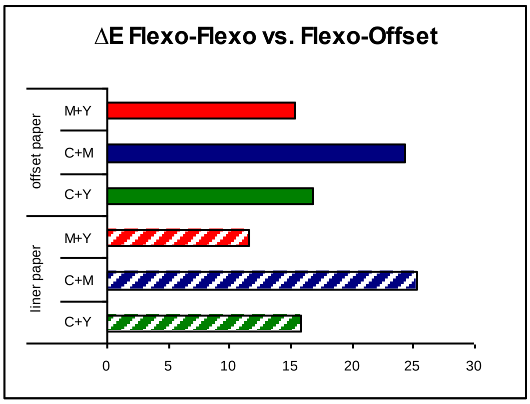
The trapping values of the green and blue hybrid prints are considerably higher than the trapping values measured on the offset and flexo reference prints. The trapping values of the red hybrid prints are very similar to the red flexo reference prints.

When discussing the trapping values of the green, blue and red overprints regarding the used printing substrate it is visible that the highest trapping values were achieved on the offset paper substrates. The lower trapping values measured on the liner paper are probably the result of the ability of liner paper to intake a higher amount of ink due to its higher surface roughness.

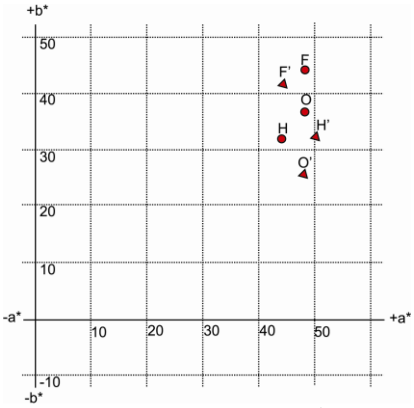
***Graph 4.*** *$\Delta E_{ab}$ Offset-Offset vs. Flexo-Offset*



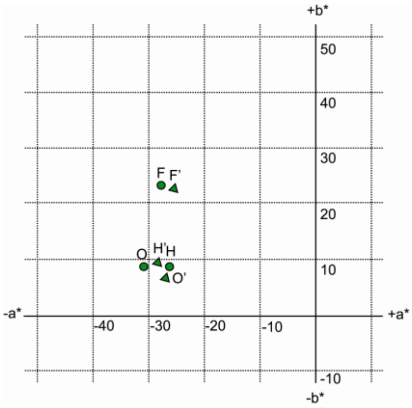

***Graph 5.*** *$\Delta E_{ab}$ Flexo-Flexo vs. Flexo-Offset*



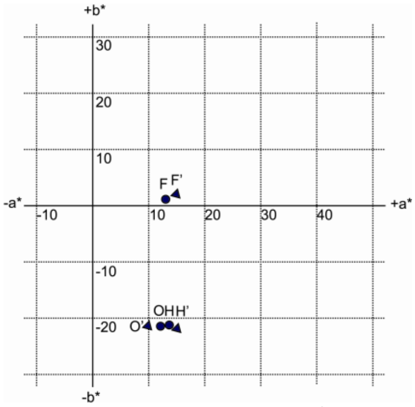

Graphs 4 and 5 present the colour differences ($\Delta E_{ab}$) between the hybrid prints and the flexo and offset reference values. The highest colour differences noticed were those between the hybrid prints and the reference flexo prints in the blue overprints. This behaviour was noticed on both substrates. The colour difference between hybrid prints and offset reference prints are smaller than those between hybrid prints and flexo reference prints.




***Graph 6.*** *CIE a*b* values of red (M+Y) overprints*




***Graph 7.*** *CIE a*b* values of green (C+Y) overprints*




***Graph 8.*** *CIE a*b* values of blue (C+M) overprints*

***LEGEND***

**F** - Flexo reference print on offset paper
**O** - Offset reference print on offset paper
**H** - Hybrid print on offset paper
**F'** - Flexo reference print on liner paper
**O'** - Offset refernce print on liner paper
**H'** - Hybrid print on liner paper

In graphs 6 to 8, a* and b* colorimetric values of overprint patches: red (M+Y), green (C+Y) and blue (C+M) are presented. The graphs show that the colorimetric a* and b* values of the hybrid prints are very similar to the offset reference prints while the flexo reference prints show certain aberrations in the green and blue overprints.

## 4. CONCLUSION

From the results it can be concluded that trapping is influenced by the surface roughness of the printing substrate - it is visible in all obtained prints that lower values of trapping were measured on the liner paper, which has much more rougher surface than the offset paper.

The hybrid prints obtained by the combination of inks of different viscosities have produced higher values of trapping in comparison with the reference flexo and offset overprints. It can be concluded that the studied hybrid prints obtained better ink acceptance than the reference prints.

The colour differences ($\Delta E_{ab}$) were smaller in comparison between the hybrid prints and the offset reference prints. This was confirmed with the CIE a*b* diagram, presenting very similar colorimetric a* and b* values of the hybrid prints and the offset reference prints.

## 5. REFERENCES

[1] D'Heureuse W., Kipphan H. (2001), Print Technologies and Design Concepts for Hybrid Printing Systems, *DDP2001: Eye on the Future - International Conference on Digital Production Printing and Industrial Applications*, Antwerp, Belgium, The Society for Imaging Science and Technology, Pages 33-38

[2] Kipphan H. (2001), *Handbook of Print Media*, Springer, Berlin

[3] Stadler P., Zahn E., Filsinger K.-H., Sauer K. (2002), United State Patent 6443058-"Combined printing method and hybrid printing machine", www.freepatentonline.com/6443058.html

[4] Zjakić I. (2007), *Upravljanje kvalitetom ofsetnog tiska*, Hrvatska sveučilišna naklada, Zagreb