# CHANGES IN THE GLOSS OF OXIDATIVELY DRIED OFFSET PRINTS DURING THE DRYING PROCESS

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***Abstract***

*In this article, we examine the changes in the gloss of offset prints after printing. At the moment of printing, the ink transfer occurs under the influence of the pressure force and several processes are initiated simultaneously: the ink is absorbed into the print medium, and the ink begins to crosslink under the influence of oxygen in the air. The ink is applied to the print medium while still wet and reflects the light radiation falling on it differently than the already dried ink. The aim of our study is to find a correlation between the change in surface gloss and the drying process of the printing ink. During the test prints, we used oxidatively dried printing ink and two paper-based print media with different structures, absorbent offset paper and glossy art paper with a coated surface. For both types of paper, measurements were made immediately before printing, immediately after printing, and in the hours and days that followed. The measurement results and their evaluation confirm that the surface gloss of the prints changes as a function of time. The drying time, the gloss change, and the formation of the cross-linked structure are influenced by the storage conditions. In the case of absorbent paper, the printing ink loses its surface gloss, while in the case of non-absorbent paper, the gloss increases during the drying process, since the ink film dries on the surface of the print medium, and the formation of the cross-linked structure also takes place here.*

***Keywords***: *offset printing, offset ink gloss, color measurement, paint drying, color change*

## 1. INTRODUCTION

The Dry-back effect: the color change of color products printed in the printing house during the drying of the ink. During direct printing, during sheet-by-sheet quality control, the ink on the prints is not yet dry, so the print is still "wet" at that moment and reflects light differently than after a few hours or days, when it has dried. Therefore, different data is received by the sensor of the measuring instrument than when examining a dry print. In a wet state, the brightness of the print is also different, and they create a different color sensation than after complete drying. The topic of my doctoral thesis is the investigation of back-drying of prints, i.e., the determination and explanation of the color change that occurs during print drying. The objective of this poster is to determine how, under given conditions, the brightness of prints changes over time during drying, and to what extent this phenomenon affects color reproduction.

## 2. MATERIALS AND METHODS

For the test, the test image (Figure 1) was produced using autotype four-color offset printing technology (Heidelberg Printmaster 52-4) on offset and coated, glossy art paper.


*Figure 1: Test image used during the test*

Preliminary material tests were performed on the printing media used under operating conditions for weight per square meter, thickness, absorbency, opacity, tear strength, and surface gloss (Table 1).

*Table 1 Properties of the printing media used*

| Property | 80 g/m² Offset Paper | 130 g/m² Glossy Coated Paper |
|---|---|---|
| Basis Weight (g/m²) (or Grammage) | *79,4* | *124,6* |
| Thickness (µm) | *98,2* | *93,6* |
| Opacity (%) | *2,3* | *1,94* |
| Surface Water Absorption; Cobb60 (g/m²) | *58,6* | *63,5* |
| Tear Strength | *16* | *11* |
| Surface Gloss (%) | *3,1* | *68,9* |

During the test printing 4-color autotype inks with oxidation drying were used, their viscosity values were between 100 and 140 Pa x S. During the permanent fixation (drying) of the printed image, chemistry (during oxidative polymerization, the carbon chains of unsaturated organic compounds break down and connect due to oxygen absorption, creating giant molecules) and physical processes (incorporation) take place. These processes and the actual drying take days. The test printing was carried out on a Heidelberg Printmaster 52-4 type 4-printing press with an alcohol dampening unit.

## 3. THE MEASUREMENTS

We performed tests on the test prints with two types of instruments:

- Operation Manual IGT Gloss Meter G75 to determine the degree of gloss.
- XRite exact Spectrophotometer to measure density, L*, a*, b* values, and tone value growth.

The prints were tested in two runs. First, immediately after printing, gradually increasing the time interval between measurements for 3 hours. Then, one sheet of the test prints was stored in a closed place under operating conditions, protected from direct sunlight, and one sheet was also kept under the same conditions, in a place where it was exposed to direct sunlight. The sheets were stored for 2 weeks, and their gloss was measured once a day. The results of the test were as follows:

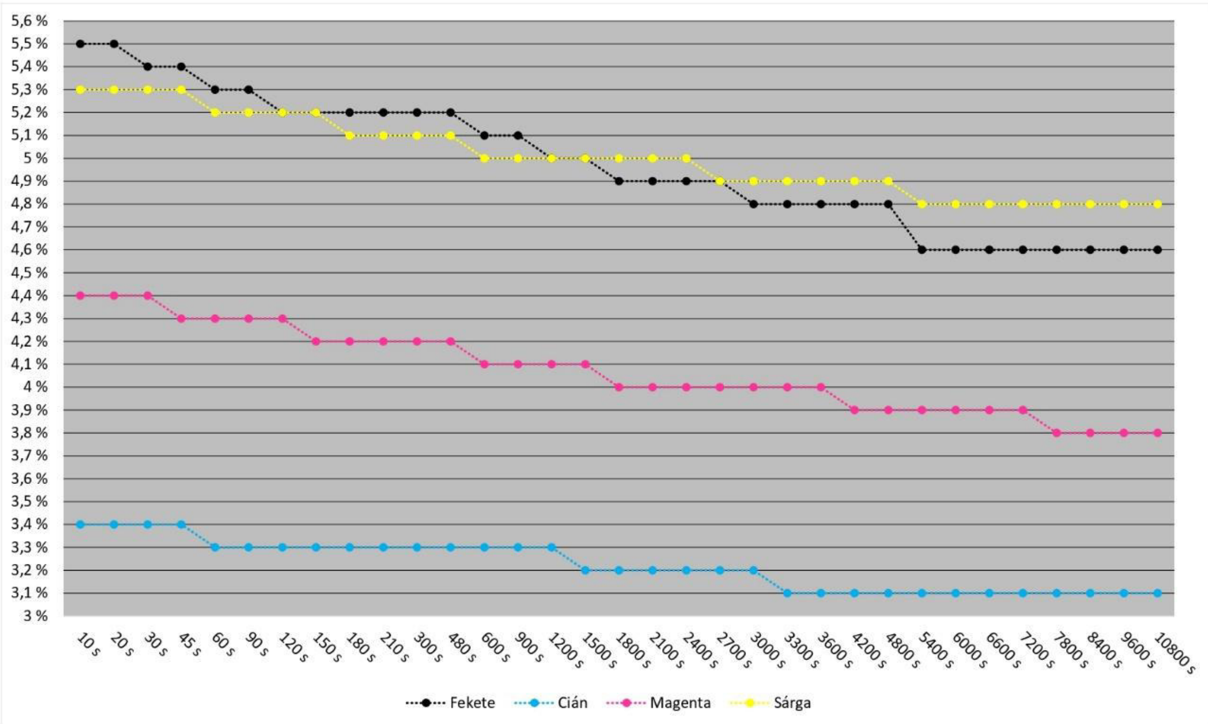



*Figure 2: Gloss change on offset paper*

In the case of absorbent, porous print media, no significant gloss change is observed after printing. The reason for the decrease in gloss value is that the binder and pigments of the printing ink penetrate more deeply into the paper fibers and drying also takes place here. As a result, a film layer with a more uneven surface is formed on the surface of the print media, which diffusely reflects the light rays. The measurement results show that the density of all colors except black decreased by approximately three to four hundredths of a value within three hours after printing, under operating conditions, under standard D65 illumination. When printing on offset paper or similar absorbent media, the color reproduction of fresh prints always appears lighter. However, in the case of black, drying is inversely proportional to the change in color perception, with black shades and solid tones appearing brighter and cooler over time. The color changes occurring during proofing and the subsequent few hours show a large color difference for black and magenta colors.

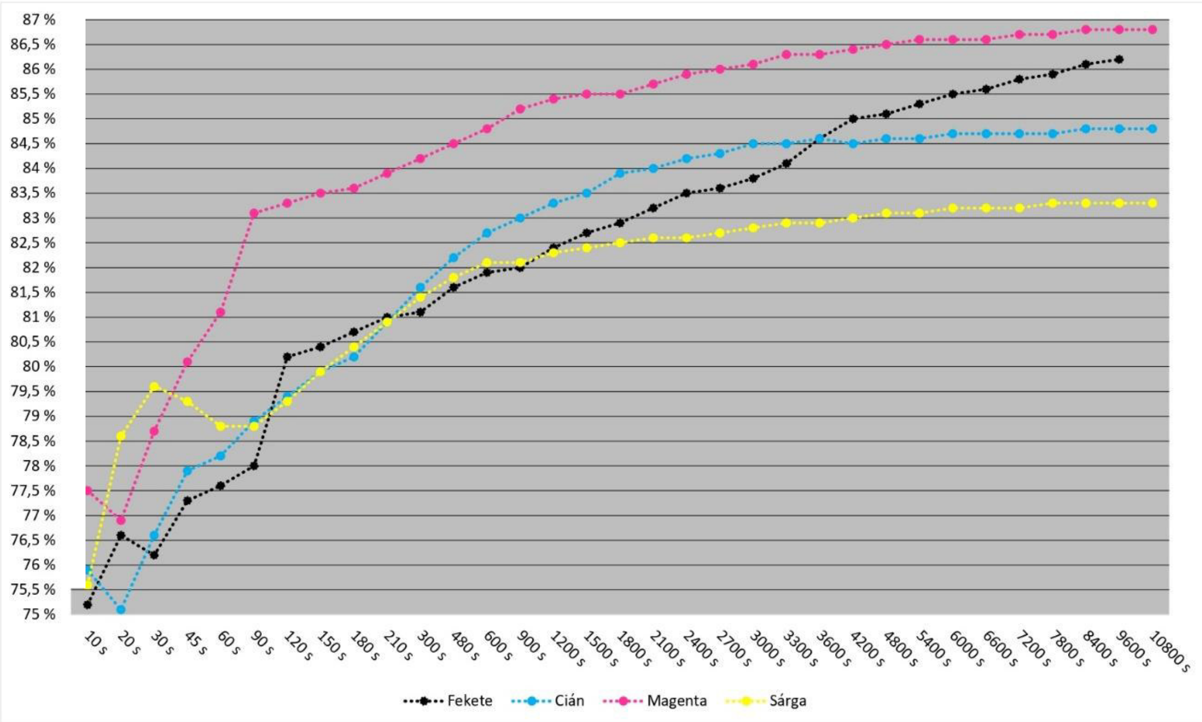
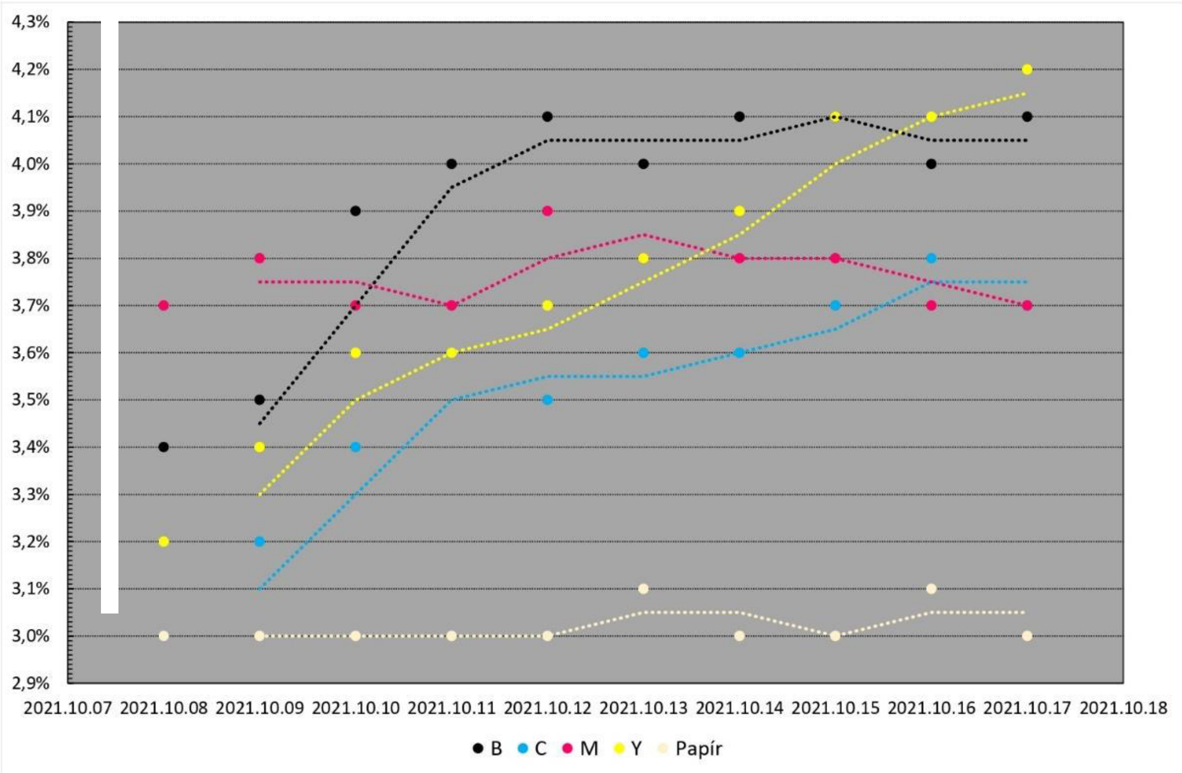



*Figure 3: Gloss change on glossy art paper*

In the case of coated, glossy, closed-surface media, the gloss of the prints changes significantly after proofing. When printing on glossy art paper, a 10% increase in gloss can be observed in the three-hour time interval of the prints. Since the drying of the printing ink takes place predominantly on the surface of the paper, the connection of the macro-molecular chains in the binders forms a uniform film-like layer, which reflects the incident light rays similarly to a specular reflection. During the drying of the printing ink, the formation of the cross-linked structure forms a top layer on the surface of the print medium. When examining the density and color changes on glossy art paper, we found that no density decrease of more than two or three hundredths occurred for any color, i.e. in the case of printing on glossy art paper, the coverage measured at the moment of printing is approximately the same as the coverage value of the prints measured again after drying. The reason for this is that in the case of print media with a closed surface structure, the paper fibers do not absorb either the pigments or the binder to the same extent as in offset papers, where the capillaries are open.




*4 Figure 4: Gloss change on closed offset paper*

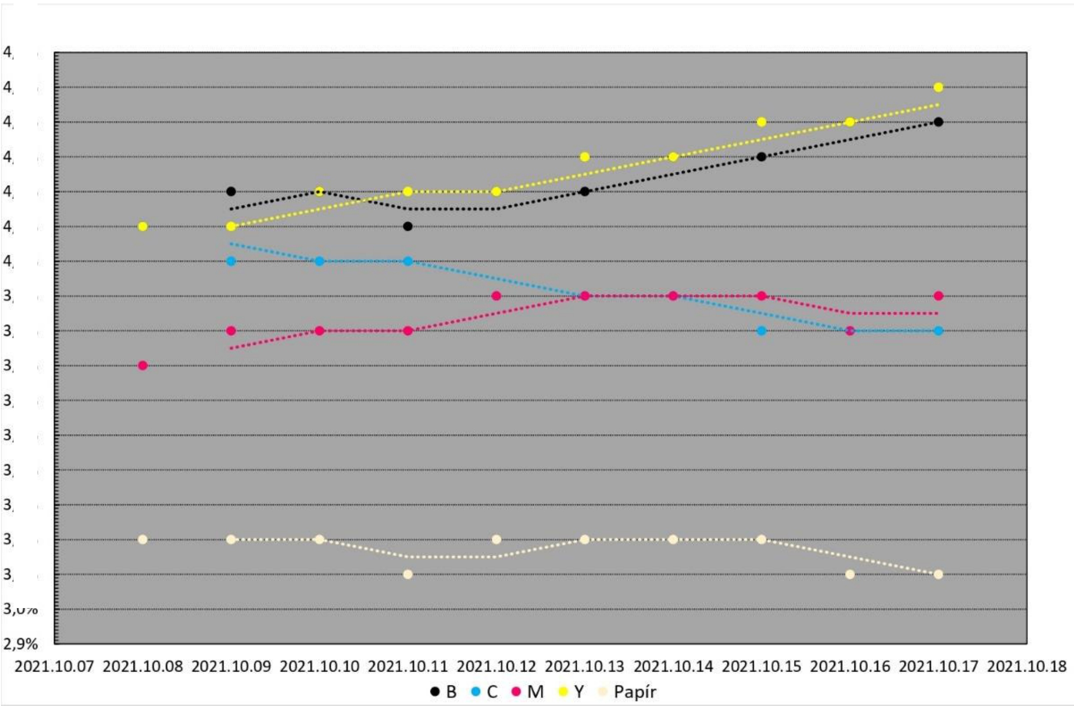



*Figure 5. Gloss change on freely stored offset papers*

Figure 4 shows the surface gloss values measured on solid fields for individual colors of the offset print stored in a locked in a drawer environment, and Figure 5 shows the gloss values of the prints exposed to sunlight and UV radiation outdoors. When printing on offset paper, the surface gloss of the prints increases slowly after printing and final drying, even in the case of sheets exposed to light and stored in a locked in a drawer environment, but under the influence of UV radiation, the prints dry faster and more evenly, and their gloss values are also more easily monitored.

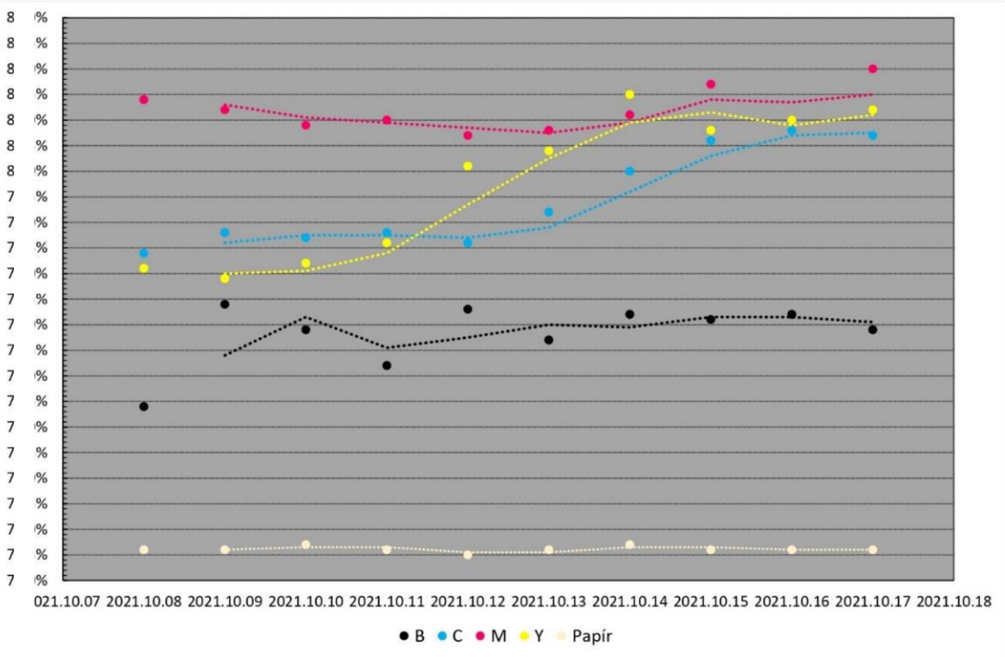



*Figure 6. Gloss change on locked in a drawer art paper*

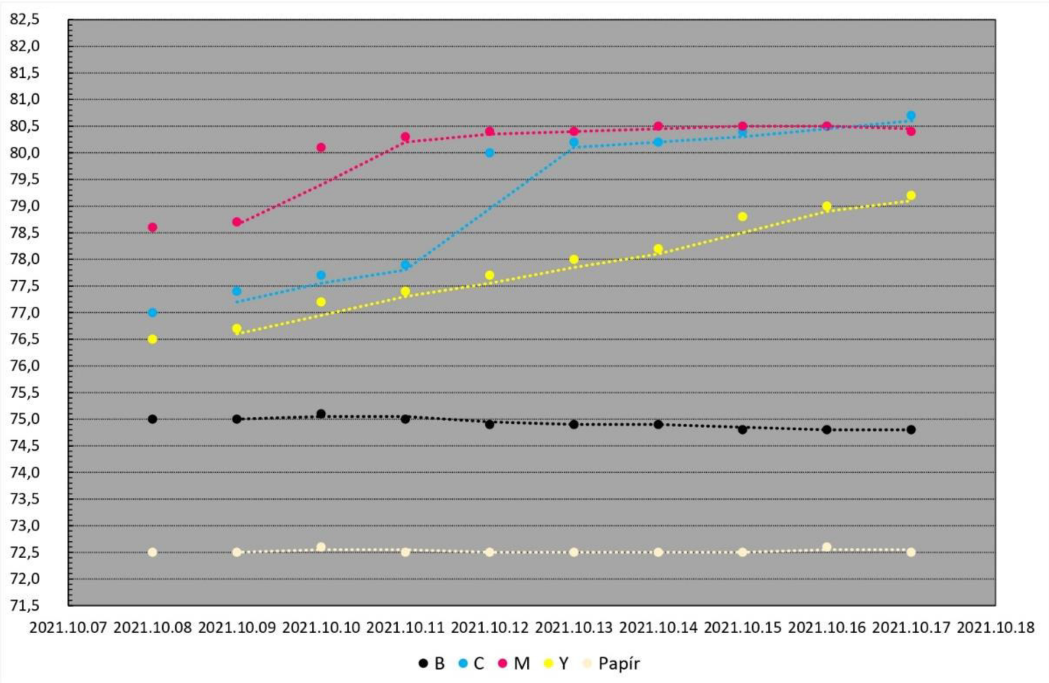



*Figure 7. Gloss change on free-standing art paper*

Figures 6 and 7 show the changes in the surface gloss values of the glossy art paper stored in a locked in a drawer environment and the print exposed to sunlight and UV radiation outdoors. Based on the results of the test, when printing on glossy art paper, the surface gloss of the prints increases slowly after printing, even in the case of sheets exposed to light and stored in a closed state. Under the influence of UV radiation, the drying of the printing ink on the surface of the paper occurs faster and more evenly, the cross-linked structure is formed sooner and their gloss value also changes more evenly.

## 4. CONCLUSION

Based on the measurement results, we have come to the conclusion that possible color changes must be taken into account during post-production in the case of absorbent print media. In periodically recurring productions, it is advisable to store the standards stored away from sunlight and UV radiation and to periodically prepare new standards, the properties of which are adjusted by objectively measuring them at the moment of printing. In the case of absorbent printing media, surface gloss cannot be achieved by increasing the ink coverage value; for this type of paper-based printing media, it is advisable to coat the prints with a varnish layer or foil in order to meet the customer's needs. In addition to mechanical protection, a unique appearance can be provided for the printed product by full-surface or form varnishing. In the case of coated, surface-treated printing papers, it is advisable to use printing inks that dry under the influence of UV radiation instead of inks that dry by oxidation polymerization, because the polymerization processes taking place in the binder of the printing ink occur immediately under the influence of radiation, and the surface gloss shows an almost final value immediately after printing. Another advantage of this type of printing ink is that the risk of peeling is reduced, thereby making production more efficient.

## 5. REFERENCES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