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COMPARISON OF OPTIMAL INKING OBTAINED BY USING THE METHOD OF MAXIMUM PRINT CONTRAST AND INKING OBTAINED BY ACHIEVING THE COLOUR VALUES IN CIE Lab

Dr. Iskren Spiridonov

Department of Printing Arts, Pulp and Paper, University of Chemical Technology and Metallurgy, Sofia, Bulgaria



One of the most important factors, influencing the image quality is the ink quantity on to the printed sheet.

Defining of optimal inking in the offset printing process is one of the crucial conditions for achieving of high quality and predictable results.

This ink quantity depends on the specific combination printing substrate – printing machine – ink.

# **METHODS FOR DETERMINATION OF INKING**

The major methods for determination and control of inking are:

- Method for determination of optimal inking density Dv (solid ink density), based on maximal print contrast. Its main purpose is to produce as deep as possible colours with the highest ink quantity, while keeping the dot gain in the admissible limits and it is characterized by good quality of the prints' dark tones.
- Method based on colourimetry, aiming at gaining of color levels for C, M, Y and Black as defined in the ISO standards [ISO 12647-2, ISO 13656, ISO 2846].



These standards provide the following interpretation. Density values can be very valuable for process control during a print run. However, in a general situation, density values do not define a colour to the required degree. Therefore, for the purpose of ISO 12647-2, reflection density values are only recommended for the determination of tone values.

Following ISO 13656, the production press operator first achieves the correct colour of the solids on the press, then reads the densities with the instrument from the OK print. The densities are then used as target values for process control during the production run. According to the ISO 12647-2, the leading method for inking determination is the colourimetry, while the densitometric measurements appear to be informative only.

# **MAIN GOALS OF THIS RESEARCH**

The major goal of this experiment was to determine and compare the optimal inking for process colours – CMYK, for two basic methods used in practice – the maximal print contrast method expressed as Dv, and the colourimetric method defined as per the ISO standards for LWC paper, printed on Heatset printing press.



## **TEST FORM USED FOR THE EXPERIMENTAL**



# **MEASUREMENTS, PRINTING CONDITIONS**

During the experiments were used positive-acting printing plates FUJI LH – PCe Brilia 1005680mm, obtained via calibrated and linearised CtPlate device Kodak Trendsetter Quantum II.

The paper that has been used is Galerie Brite 60 g/m2, SAPPI. Inks – Maxink Phantom HD OHD 9300.

The printing press, which has been used is web offset heatset press KOMORY SYSTEM 40.



The printing process was performed at standardized conditions.

All measurements are in accordance with ISO 12647-1:

- D50 illuminant
- 2° observer
- 0/45 or 45/0 geometry
- black backing

Colour characteristics of used papers (print substrate colour) are in accordance with ISO 12647-2 tolerances (L $\pm$ 3, a $\pm$ 2, b $\pm$ 2).



# EXPERIMENTAL

In the above-mentioned conditions, were printed series of samples characterized by gradual smooth changes in ink quantity – from underinking to overinking.

In order to achieve the goals of the experiment, series of measurements of Dv and Print Contrast have been performed (from underinking to overinking) for defining the optimal inking by the method of maximum print contrast for Cyan, Magenta, Yellow and Black.

A statistical analysis of the results was performed.



Figure 1. C=f(Dv),  $\Delta E=f(Dv)$  for Cyan



Figure 2. C=f(Dv),  $\Delta E=f(Dv)$  for Magenta



Figure 3. C=f(Dv),  $\Delta E=f(Dv)$  for Yellow



Figure 4. C=f(Dv),  $\Delta E=f(Dv)$  for Black

# DEFINING THE INKING BY MAXIMAL PRINT CONTRAST

The graphs show clearly visible peaks, visualizing the maximal value of the print contrast and its corresponding Dv.

The optimal inking has been defined through the optical density of 100% solid patch - Dv.

Experimentally defined values for optimal quantity of printing ink for the LWC paper are shown in Table 1.



Table 1. Experimentally defined values for optimal quantity of printing ink by the Print Contrast Method

Type of paper	Dv (Optimal density defined by maximal print contrast method)					
	Cyan	Magenta	Yellow	Black		
LWC	1.50	1.40	1.25	1.65		

# **DEFINING THE INKING BY ISO STANDARDS**

In order to determine the inking via the second methods, series of colourimetric measurements were performed on printing sheets with different ink quantity (from underinking to overinking). The major goal was to determine the ink quantity, which provides the smallest colour difference ( $\Delta$ Emin) according to the reference values defined in ISO standards [ISO 12647–2, ISO 2846].

Table 2. Experimentally defined values for smallest colour differences –  $\Delta$ Emin and corresponding (relevant) ink quantity defined by Dv

Paper	Cyan		Magenta		Yellow		Black	
LWC	$\Delta E_{min}$	Corresponing	$\Delta E_{min}$	Corresponing	$\Delta E_{\text{min}}$	Corresponing	$\Delta E_{min}$	Corresponing
		D <sub>v</sub>		D <sub>v</sub>		D <sub>v</sub>		D <sub>v</sub>
	1.44	1.22	4.10	1.46	3.8	1.25	6.6	1.42



Figure 1. C=f(Dv),  $\Delta E=f(Dv)$  for Cyan



Figure 2. C=f(Dv),  $\Delta E=f(Dv)$  for Magenta



Figure 3. C=f(Dv),  $\Delta E=f(Dv)$  for Yellow



Figure 4. C=f(Dv),  $\Delta E=f(Dv)$  for Black 17

# **RESULTS AND DISCUSSION**

### Analyses of the achieved results shows:

- It is clearly visible from the graphs that for some of the colours exist relatively big differences between the values of Dv, where C has highest levels, and Dv where ∆E has lowest levels.
- The experimental results and the comparison of the data in Tables 1 and Table 2 shows that the optimal inking, determined by the two methods differ substantially for Cyan and Black. A relatively big difference in Dv is observed – about 0.3 units for Cyan, and 0.23 units for Black.
- While for others colours the difference is smaller 0.06 units for Magenta and for Yellow it has no difference for obtained ink quantity defined by Dv.



# CONCLUSIONS

- The results achieved are important from practical point of view. They lead to the conclusion that it is necessarily not only to achieve the maximal accuracy of reference colours from ISO standards, but also taking into strict consideration the concrete printing conditions – as dot gain, print contrast, screen frequency, type of printing press, ink properties (viscosity, adhesion to substrate) etc.
- It is clearly visible from the experimental results and graphs that exist relatively big differences between the values of Dv, where print contrast has highest levels, and Dv where ∆E has lowest levels. This means that the implemented two different methods for inking determination result in different levels for Dv.



- According to the recommendations of the ISO standards, the leading issue is to achieve of the reference colour values for C, M, Y, K, while the concrete technological printing process conditions are not taken into consideration, for example – dot gain, type of printing plates, ink types, printing paper specificity, printing press, screen frequency etc.
- 4. The inking process, as determined by the maximal contrast method takes into account all above mentioned technological conditions, except for the ink color characteristics.



- Both methods for inking determination have their advantages and disadvantages. The advantages of one of the methods appear to be disadvantages of the another one.
- 6. In order to reach the level of maximal accurate colour reproduction, the condition to achieve colour characteristics C, M, Y, K is not sufficient, without taking into consideration the concrete technological conditions. Taking into account the concrete printing conditions for determination of the inking, but without considering ink colour characteristics would not lead us to predictable results too.



- 7. From the point of view of the human perception, it is very important to achieve maximal accurate reproduction of key tones that could be fulfilled only if the Print Contrast method is implemented.
- 8. The experimental results lead to the idea that it is necessarily to take into consideration both methods for inking determination, while the best performance from the viewpoint of accuracy of colour reproduction is the generation of ICC colour profiles. The experience has shown that during the ICC profile application, both concrete technological conditions and ink color characteristics are taken into consideration.



# **THANK YOU!**