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Methods of Measurement the Quality Metrics in a Printing System

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Abstract. One of the main criteria for choosing ink as a component of printing system is scumming ability of the ink. The realization of algorithm for estimating the quality metrics in a printing system is shown. The histograms of ink rate of various printing systems are presented. A quantitative estimation of stability of offset inks emulsifiability is given.

1. Introduction

A distinctive feature of offset printing is that in different ink areas, each of which corresponds to a certain color gate, the thickness of the ink layer is contacting with a different amount of fountain [1-3]. Considering this, the degree of ink layer scumming in one inker is not the same and varies in different color zones [2-4]. The same ink with different degrees of emulsification can have unstable rheological properties that lead to destabilization of the color reproduction process. Accounting for divergence of quality metrics from the nominal value represents one of the priority problems.

2. Objects of Research

For quantitative estimation the degree of ink scumming and its effect on the formation of an ink layer on paper researches were carried out on a sheet-fed offset printing machine Man Roland 704. The main components of the printing system are the paper Titan gloss 115 gr/m²; printing ink of various manufacturers – LitiFlora FTX (FlintGroup) (1); Cristal (SunChemical) (2); Triumf (SunChemical) (3); ToyoInk TK Nex NV100 (4).

Test samples were obtained from test plates that included:

- bars, providing different inkload by each color and control 100 % solid plates for CMYK along the valve;
- 100 % solid plates and binary overprints with consecutive measurement of them, i. e. C+M, M+Y, C+Y;
- printing of 1000 sheets and measuring in two zones with different amount of inkload.

Measurements of the quality metrics in the printing system in accordance with the ISO were carried out using an X-Rite spectrophotometer, a Techkon 410 densitometer.

A quantitative estimation of ink absorption in the paper structure was evaluated on the basis of images obtained with a scanning electron microscope of the JSM7500F JEOL model at an accelerating voltage of 10 kV and a beam current of $2 \cdot 10^{-9}$ A [5].



3. Results and Discussion

Experimental results are presented in Table 1 and in Figure 1.

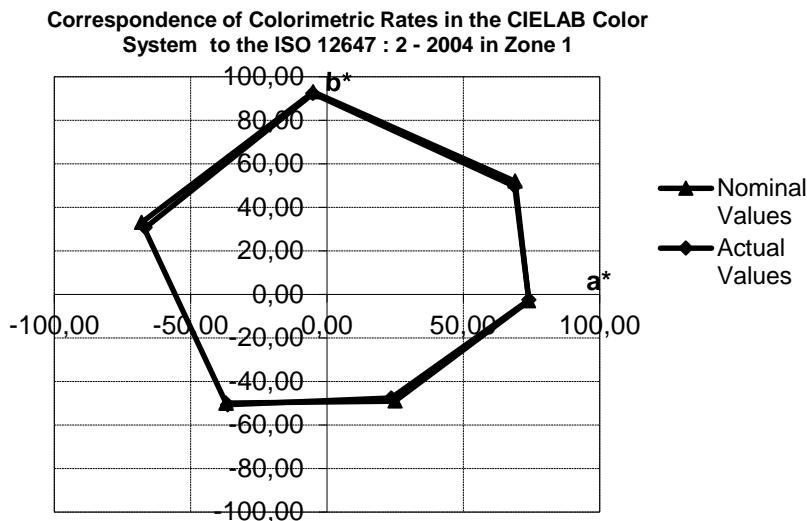


Figure 1. Correspondence of colorimetric rates in CIE LAB system.

Table 1. Optical Density and color difference dE

| | black | | cyan | | magenta | | yellow | |
|--------------|-------|-------------|------|-------------|---------|-------------|--------|-------------|
| | D | dE^*_{ab} | D | dE^*_{ab} | D | dE^*_{ab} | D | dE^*_{ab} |
| LitoFloraFTX | 1.7 | 1.82 | 1.45 | 1.06 | 1.38 | 0.69 | 1.24 | 1.21 |
| Cristal | 1.71 | 2.23 | 1.37 | 1.74 | 1.33 | 2.98 | 1.23 | 3.24 |
| Triumf | 1.64 | 3.23 | 1.46 | 2.56 | 1.42 | 1.58 | 1.24 | 1.65 |
| ToyoInk | 1.68 | 2.06 | 1.41 | 2.39 | 1.39 | 4.02 | 1.21 | 2.89 |

The analysis of the values of coloring gate opening by the color zones during printing the same sample on the same carrier presents the difference in ink rate comparatively to a number of inks in per cents. Graphical analysis of such researches is presented in Figure 2-4.

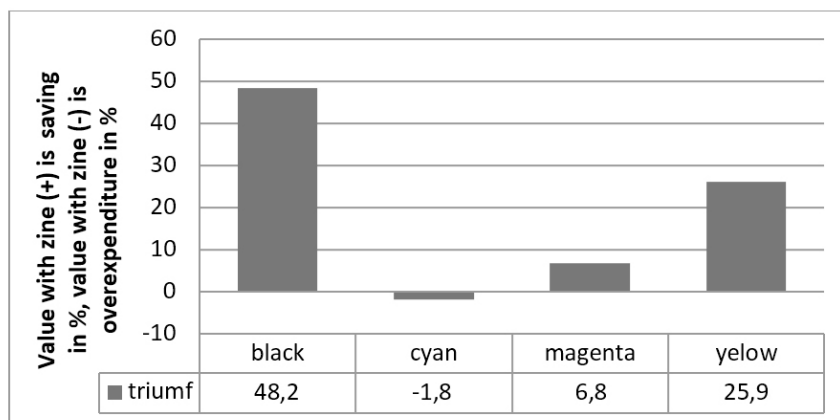


Figure 2. Histogram of Ink Rate of Sun Chemical Triumf to LitoFlora FTX.

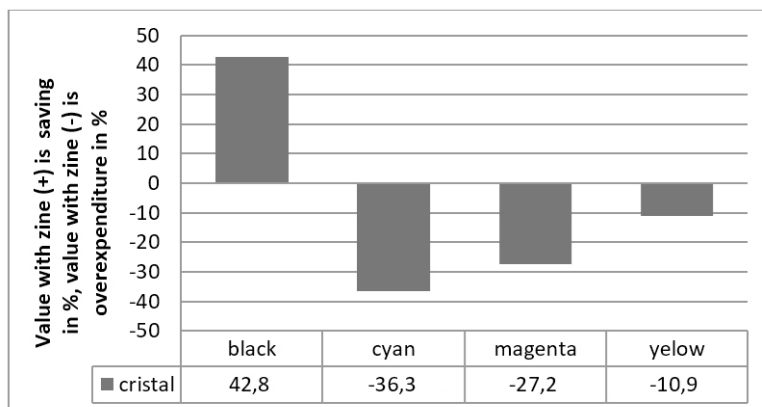


Figure 3. Histogram of Ink Rate of Sun Chemical Cristal to LitoFlora FTX.

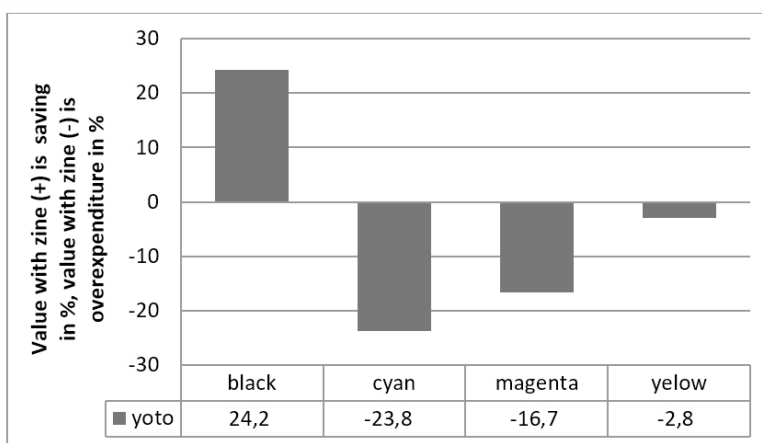


Figure 4. Histogram of Ink Rate ToyoInk to LitoFlora FTX.

The data of ink layer distribution in the surface and solid layers of the paper structure are well-formed with the results of estimating the ink rate. The visualization of the obtained data is shown in Figure 5. To estimate the emulsifiability of offset inks, an algorithm has been developed. It includes:

- Constructing the dependences of the degree of ink scumming on the under test parameter of the fountain solution in the form of a kinetic curve. A distinctive feature of this stage is that the mixing of ink with the fountain solution is realized in three cycles with different time periods; stirring rate is 400 rpm; the temperature of the fountain solution and the ink emulsion is kept at 25 degrees during mixing.
- Analysis of results. The stages boundaries on the kinetic curve of ink scumming were determined in the following order:
 1. The initial and final points of ink scumming are determined. The origin is the point of intersection of the curve with the OX axis. The end point is the point on the curve equal to the final value of the ink scumming degree at the 300th second.
 2. Two tangents to the two most clearly defined linear sections of the curve are drawn. As a result of the intersection of the tangents with the kinetic curve the segments that characterize the stage of active absorption (stage II) and the saturation stage (stage IV) are obtained. The segments on the kinetic curve characterizing the initial stage of ink scumming (stage I) and the deceleration stage (stage III) are determined.

Practical realization of the estimation of ink emulsifiability according to the developed procedure and at the concentration of isopropyl alcohol in the fountain solution from 0 to 5% showed that the SunChemical Cristal ink reduces the degree of saturation by 21.2% and maintains a tempered stability. The printing ink LitoFlora FTX reduces the degree of saturation by 2.4%. The percentage range of alcohol content in the fountain solution (in the referred above range) and in the ink emulsion will not destabilize the printing-technical properties of the LitoFlora FTX ink.

On the bases of analysis of the scanning electron microscopy results with SEM images it is found that the distribution of ink layer on the paper surface, *ceteris paribus*, is determining by the degree of ink scumming during printing that adequate mappingin Figure 5.

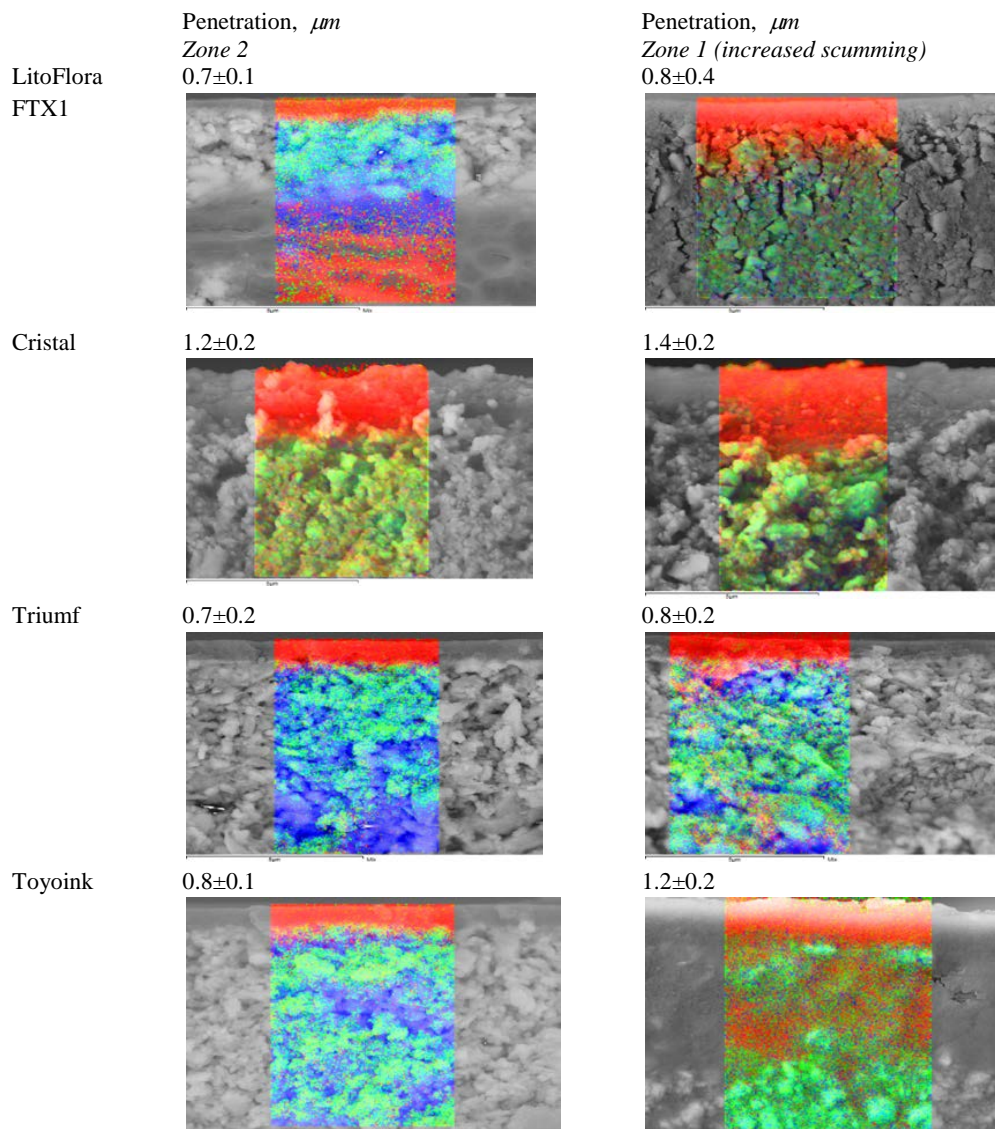


Figure 5. The influence of degree of ink scumming on the formation of an ink layer in binary overprints (C+M).

4. Conclusion

In conclusion, Optimum selection of the components of the "ink-substrate" system ensures the quality of printing in accordance with the requirements of ISO 12647-2: 2004, which is achieved through the

diagnostics of ink. The algorithm of each stage of quality control in the "ink-substrate" system is an integral part of the development the automated system for predicting the quality of the ink coating.

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