

Printing Inks' Characteristics

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Abstract: Hybrid inks are often used for the advertising products because a variety of effects can serve as an added value. Much attention is paid to the inks application settings, using the hybrid inks at the hi-tech offset equipment and color features of images. The thorough research of the different printing settings with the use of modern inks and efficient equipment, is an urgent problem. Work reveals some new facts about characteristics for printability such as emulsification and influences of ink's additives on color characteristics of imprints. The experimental inks were developed to define the technological settings of offset printing. The result of research showed that conventional inks have the considerably high degree of emulsification comparing to experimental hybrid inks. Also it was discovered that the UV components influence the emulsification. An optimal water-ink balance and stable printing process can be achieved with adding of 2%-10% of the UV-component to the hybrid inks. Inks application and drying settings as well as color features of the imprints are analyzed in the context of offset printing.

Key words: Offset printing, UV-component, emulsification, printing ink, hybrid inks, color characteristics.

1. Introduction

The color stability during all the production cycle and the printing properties are considered in the paper. The subjects of the research are the offset inks application settings. It is noted that the special place among the inks is occupied by hybrid inks. This theme is important because the particular printing requirements of offset printing inks must be taken into account when composing the ink.

Sheet fed offset presses are termed hybrid presses if they are equipped to apply inks containing a blend of conventional and UV components followed by a final UV coating, or oil-based components followed by an aqueous coating. Hybrid inks unite two different drying properties: they can dry by oxidation and by penetrating the substrate, like conventional inks, but react to UV radiation like UV inks [1].

Apart from the economic logic of using standard inks where the sheets are to remain uncoated, hybrid

inks without coating would be both dull and vulnerable to scratching and abrasion. Hybrid inks plus inline coating were defined as the best choice of printing process, which guarantees a good printability and a lot of gloss effects in the imprints. Hybrid technology is a leader among printing processes [1-9].

However, the hybrid technology progress has slowed down through a series of problems that arose during the introduction of new technologies, equipment and materials. That is why detailed studies, explanations and science-based recommendations are required to normalize the processes and their stability. So the studying of all the details of this technology is very important.

Ink is the most problematic component of the printing process, so it is most commonly studied and discussed in the scientific and technical press. Due to the competitive environment and the need to manufacture the high quality products modern inks should meet the following requirements [2, 4]:

- Color accuracy, intensity and brightness;
- Deep tone and high ink opacity;
- Fast drying;

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- Stable adhesion to the substrate and mechanical damage resistance;
- Rheological properties should match the certain printing equipment;
- Light and difficult environment resistance;
- Ecological compatibility.

Various investigations of hybrid inks [1-9], showed that their viscosity and stickiness is higher comparing to conventional inks, but lower comparing to the UV inks. The hybrid inks behavior during the emulsification is more stable comparing to UV inks but less stable comparing to conventional inks. UV inks have a higher dot gain and different ink mixing properties, hybrid inks have the same tonal transfer characteristics as standard inks.

The use of fountain solution containing isopropyl alcohol with the hybrid and UV inks can cause significant distortion of images even though the printing settings have not been changed [10, 11].

Printing quality of hybrid inks with UV-varnishing and drying depends on the thickness of ink and varnish and the degree of inks emulsification [2].

Hybrid imprints lose their luster faster comparing to conventional technology [2, 11-13].

Therefore, the experimental data [1-13] suggest that further studies of all of hybrid technology components is an urgent problem.

2. Experimental Methods and Characterization

Experimental samples of the offset hybrid inks were formulated to determine the degree of emulsification and color stability in the printed copies. They included different amount of UV components, surface-active substances and special additives for color stability and surface uniformity.

Fountain solution is evenly distributed in the ink in the form of tiny droplets, mixing with ink to form the emulsion. Water-ink balance is very important in offset printing, and all deviations lead to problems when printing.

Inks containing more intense pigment form a thin film, narrowing the limits of the balance. Conversely, the less pigment, so should be thicker ink film and allowed greater water content. Emulsification significantly influences to the properties of inks, their viscosity, stickiness, and thixotropic properties. It can decrease the intensity of color, change inks' spectral characteristics, color coverage, etc..

To achieve the best print quality pH level of experimental inks should not be below 4.7. Fountain solution was prepared from concentrate Stabilat D (Druckerei Service) in compliance with the pH level 4.7-5.5. Number of UV component varied between 2%-28%.

The degree of emulsification (E , %), was calculated as the ratio of fountain solution, which turned into the ink, to the mass of ink which was taken for research. It was conducted on 5 measurements for each of 7 samples of the ink.

To experiment with absorbent substrates we took offset and coated paper. Polyvinylchloride and polystyrene were taken to research the printing on non-absorbent materials. Testing of the experimental inks was carried out by the laboratory printing devices LPU-1 at constant at constant pressure (30 kg/cm) and speed (2.5 m/s). These conditions in combination with the use of printing plate and the printing cylinder with a radius of 3.25 cm and a width of 2.7 cm correspond to values of 1.11 MPa pressure and productivity print 9,000 copies per hour.

There are the average parameters for the sheet-fed offset medium format press.

Using Datacolor 110 R spectrophotometer, we measured spectral indices derived imprints and built graphical dependence of reflectance (R , %) of the wavelength of the reflected light (λ , nm) in the area of the visible spectrum radiation, 400-700 nm.

Using the mathematical optimization and simulation, we constructed regression equations depending on the imprints properties received by the printing inks with different content of UV component

(x_1) and surfactants (x_2).

$$Y_1(x_1, x_2) = 19 - 4.17x_1 - 0.92x_2 - 1.19x_1^2 - 0.78x_2^2$$

$$Y_2(x_1, x_2) = 31 + 13x_1 - 2.28x_1^2$$

We have found such an ink composition in which the degree of emulsification (Y_1) is not less than 20% and curing speed (Y_2) does not exceed 20 s. Contour curves (Fig. 1) were constructed with the use of Math Lab software. Analysis of contour curves confirmed the experimental data regarding the optimal percentage of the UV component of hybrid inks.

3. Results and Discussion

As shown in Fig. 2, the degree of emulsification hybrid model inks depends on the amount of UV component and varies significantly.

It is believed that the optimum emulsification should be in the range of 20%-40% [7]. In this case, the printing process will go smoothly.

Based on the results of measurements we can say that 2%-10% of UV component is enough to optimal water-ink balance and stable printing process.

Studies have shown patterns of interaction between paper and ink in the printing process, which correspond to long-held beliefs [9]. Our research is in line with previous results and show the need for further study of hybrid inks.

Ideally, the ink must fully absorb the radiation in one of the zones of the spectrum and fully reflect in the other two. The ideal magenta ink have 100% reflection ($R = 100\%$) in the blue and red zones and 100% absorption ($R = 0\%$) in green (Fig. 3, curve 3) [3]. However, In the actual production conditions we can not get a perfect reflection coefficient so the actual process inks differ significantly from the ideal, which limits the accuracy of color reproduction. Spectral characteristics of real of real ink are influenced by such factors as coloring agent tone, binding agent, ink additives, whiteness of substrate and many other.

Spectral characteristics and reflectance curves obtained in the study (Figs. 4 and 5), enable us to determine zone of the spectrum where the light is

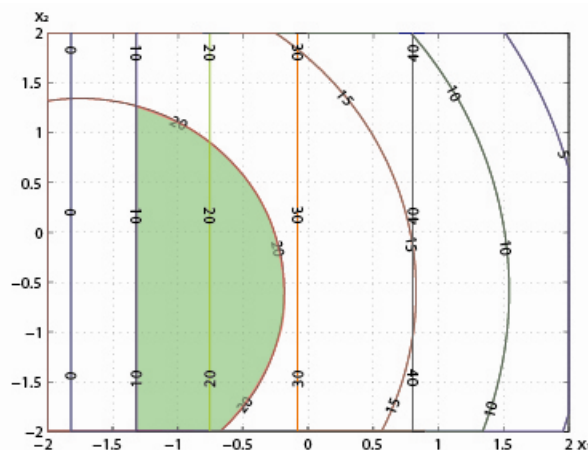


Fig. 1 Contour curves.

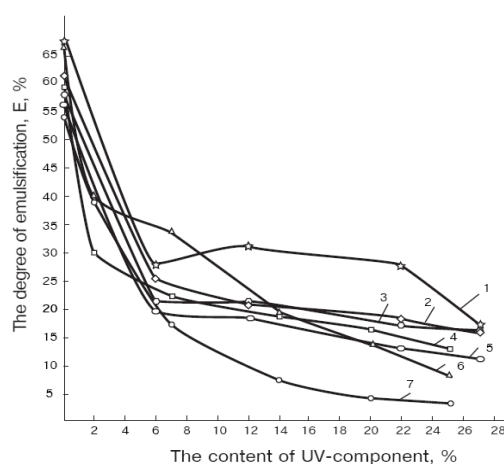


Fig. 2 The degree of emulsification of experimental inks, depending on the content of UV-components: (1) mi1, (2) mi2, (3) mi3, (4) mi4, (5) mi5, (6) mi6, (7) mi7.

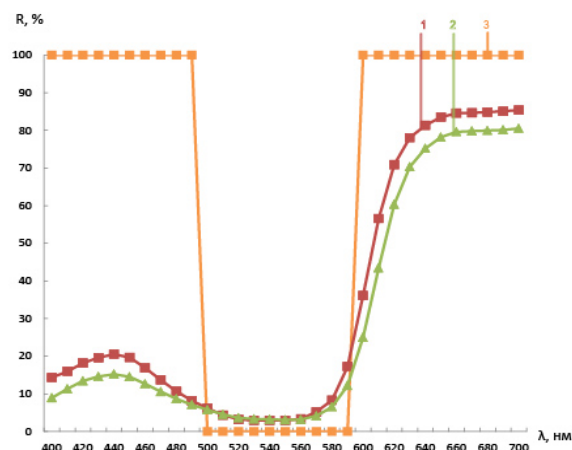


Fig. 3 Hybrid ink reflectance curves (magenta): curve 1, real magenta ink printed on non-adsorbent materials; curve 2, real magenta ink printed on adsorbent materials; curve 3, an ideal ink.

absorbed or reflected, and to assess the degree of ink contamination on a particular area of the spectral range .

As can be seen in Fig. 4a and 4b, curve 3), the best reflectivity, namely maximum values of the reflection coefficient in the blue and red zones for experimental magenta ink (Fig. 4) is achieved when printing on PVC, compared to other researched substrates .

However, if we compare printing on absorbent and non-absorbent substrates we can see that the reflectance curves received while printing on non-absorbent substrates are close to the curves of

ideal ink (Fig. 5). When printing on paper with the experimental magenta hybrid inks, the samples had low reflectivity on the blue part of the spectrum (400-500 nm) indicating the shift to the blue color (Fig. 5a, curves 2 and 3)). On the red part of the spectrum 600-700 nm a higher reflectivity was observed in coated paper (Fig. 5b, curve 2).

The reflection coefficients of the hybrid purple ink with increased content of the UV-component applied to PVC were cleaner on the 400-470 nm part of the spectrum and were close to each other on the 600-700 nm part of the spectrum. So, we can state that

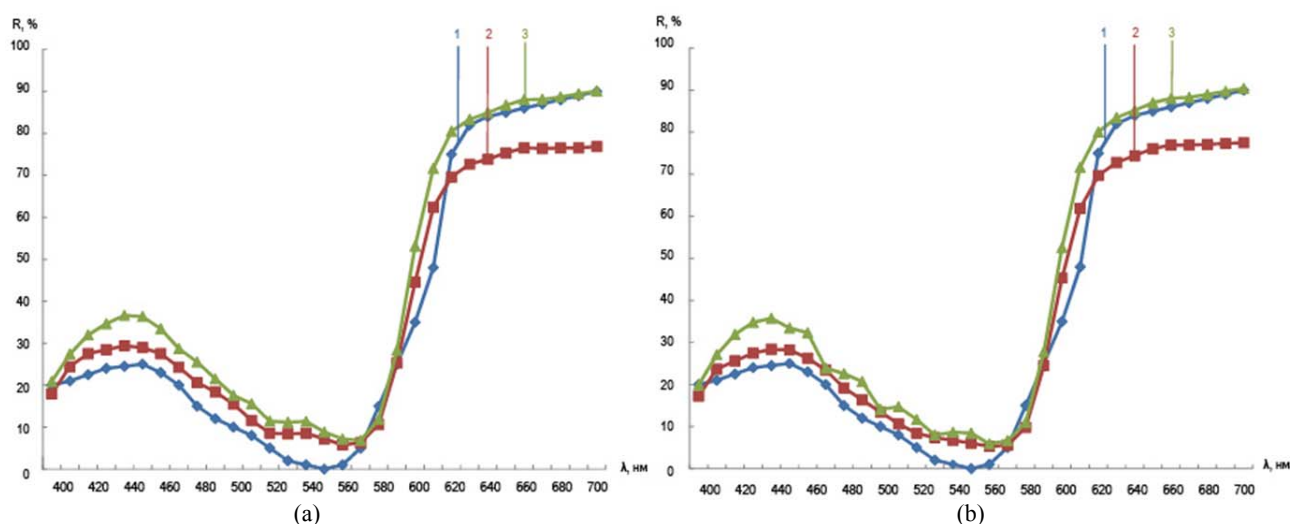


Fig. 4 Reflectance curves, when printing on PS (curve 2), PVC (curve 3): real magenta ink: a, b (curve 1); hybrid ink (2% UV): a (curve 2 and 3); hybrid ink (10% UV): b (curve 2 and 3).

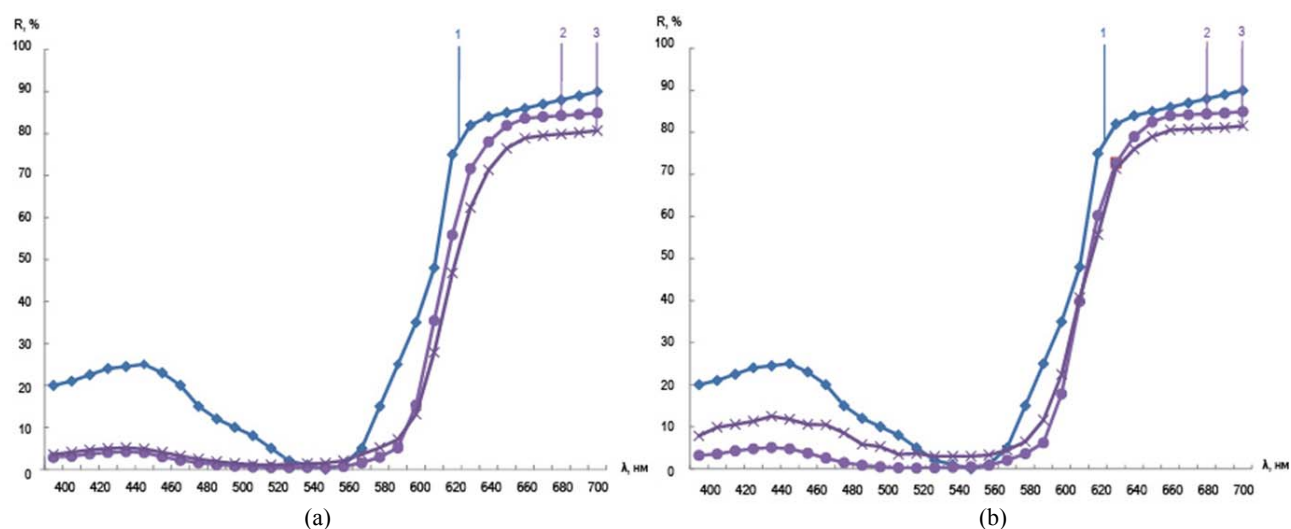


Fig. 5 Reflectance curves, when printing on Magno Satin Sappi paper (curve 2), UPM Gloss (curve 3) real magenta ink: a, b (curve 1); hybrid ink (2% $\text{Y}\Phi$): a (curves 2 and 3); hybrid ink (10% $\text{Y}\Phi$): b (curves 2 and 3).

the greater amount of UV component does not distort the spectral characteristics significantly and contributes to their improvement.

Thus, we can conclude that various agents added to experimental inks can improve optical and spectral characteristics of the imprints and stabilize the color reproduction.

4. Conclusions

(1) Our study determined the degree of hybrid inks emulsification depending on the amount of UV component;

(2) The study concerned the characteristics of the application and drying of inks, depending on their composition and quality of the paper;

(3) Our research reveals the impact of technological factors on the ink drying and color characteristics of prints made on different substrates.

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