ORIGINAL SCIENTIFIC PAPER

ACTA GRAPHICA 244

CMYKIR Separations for Printing on Transparent Polymer Materials

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Abstract:

Hidden information on food packaging are carried out with INFRAREDESIGN technology procedure. The procedure implicates merging of two independent visual RGB images, followed by compound separating in process CMYKIR components. Graphic reproduction embodies picture elements - pixels with two independent appearances in two light spectrum. The first range is a visual space that we see with the bare eye and the other range of the near infrared, that is registered instrumentally. One can distinguish two information using Z glasses that selected by the absorption of light at 1000 nm. Printing on a transparent polymer material, carrying a transparent image that is designed as a protective prints with individualized line forms. Dyes are mixed as twins respecting the norm DIN4 Flexographic rare and transparent dyes viscosity 22 s. The two dyes twins have the same spectrogram in the area of 400 to 700 nm, and different spectrogram Z point near infrared spectrum.

Keywords:

Infraredesign, CMYKIR separation, Flexographic print on polypropylene, Near infrared spectrum, Security graphics, Z parameter

1 Introduction

An article in the journal Polymer (J. Žiljk Vujić et al, 2013.) initiated the study of twins dyes with printing on transparent polypropylene in a variety of colors. Examples of the mathematical model of relationship twins dyes, gave results in polymer technologies through general regression relation X40 (4). It is a relationship between the composition of dyes without carbon black component and the composition of dyes with 40% coverage carbon black dyes for flexographic printing on polypropylene. Joining and separation of IRD images depend on the "infrared color setting" for which develop special mathematical models specifically for the newspaper printing (A. Rajendradrakumar and V. Žiljak, 2011), and printing on textile and leather (V. Žiljak et al, 2011).

CMYKIR separation was published for the first time in 2009 in the journal "Infrared Physics and Technology" (Vol.52) (V. Žiljak et al, 2009). Expansion of discussions and general principles of double images were published in the journal "Journal of information and organizational science" VOL. 33 (I. Žiljak et al, 2009). The IRD development procedure study many colleagues around the world to search for the twins dyes for specific situations (L. Chao et al, 2013). Their greatest problem is to find a general relationship between RGB, Xo, Xmax for specific materials and dyes. Contrary to search these interdependencies dominated by carbon black colorant, a significant shift in research the IRD theory works are with ultraviolet dyes that have a substantial absorption in the infrared spectrum (B. M. Kolarić et al, 2015).

During studying new dyes for digital printing on transparent polymer materials, there is a set of extensions to the data that define the parameters in the matrix Apoliprop. Structure of the new values of A are connections initial composition of the color tones Xo with the final composition of the same X40 tones over relations:

$$D_C = Co/Mo + Co/Yo \qquad (1)$$

$$E_Y = Yo/Mo + Yo/Co \qquad (2)$$

$$G_M = Mo/Co + Mo/Yo \qquad (3)$$

$$X_{40} = A^{\text{poliprop}} \bullet T \qquad (4)$$

$$X_{40} = \begin{bmatrix} C_{40x} \\ M_{40x} \\ Y_{40x} \end{bmatrix} \qquad (5)$$

$$T = \begin{bmatrix} G_M \\ E_Y \\ D_C \\ Y_0 \\ M_0 \\ C_0 \\ 1 \end{bmatrix} \qquad (6)$$

Twin dyes matrix Apoliprop has new parameters based on 71 measurements of twins given in chapter 2. Twins dyes in point K40 are needed in studies of hiding or designs that insists on equal status tones in visual spectrum. It is a new approach to GCR procedure replacing CMY with K because K is given in advance, before the start of the separation. The reason is to hide, camouflage, merging two independent images in a new IRD graphics reproduction. The principles and set theory about merging two images is published in 2010 in "Journal of Imaging Science and Technology" (K. Pap et al, 2010).

Mathematical model for flexographic printing on polypropylene material with three independent variables was published in 2013 (M. Friščić et al, 2013). Any of four CMYK process dye depends on the other three default Xo dyes for given K40. Examples are realized with the use in packaging the food in transparency foil. After this work it became clear that some areas have color inflection which encouraged new research into the interdependence of Xo and X40 state of dyes. They were tested various proposals of enlargement the linear regression model but the final set is six independent variables. Vector T has been expanded with GM, EY, and DC variables that enter the information of the quotient sum value of dyes in the state Xo. This gave the different matrix A model which is published in this paper.

2 New regression coefficients for CMYKIR separation

It is a clear transparent label for the PET bottles that are filled in with water which is also transparent. In order water retained its natural appearance (transparent) it is necessary that the label carries the less printing while being given the necessary information and to set security mechanisms to protect against counterfeiters. Transparency of the label, dyes, bottles is an aggravating factor to ensure of the original natural-looking water. Applied is the norm DIN4 Flexographic rare and transparent dyes viscosity 22 seconds (1000 ccm volume and diameter 4 mm leakage).

Connecting the two images is performed CMYKIR separation processes including CMYKIR merges the two images by IRD method. The goal is to hide. In this direction is investigating the composition of dyes that will for our eyes equalize twins colors. We have developed different mathematical models, for each material modified parameters in regression depending on the material, inks, toners, generally on colors with which to hide the image is

$$A = \begin{bmatrix} 2.643 & 6.199 & -1.655 & -0.2098 & -0.067 & 1.69 & -63.47 \\ 0.9278 & 1.448 & +1.832 & -0.0097 & 1.379 & -0.088 & -46.93 \\ -5.163 & 3.235 & +4.668 & 1.069 & 0.3934 & -0.229 & -43.22 \end{bmatrix} \quad (7)$$

performed. Perennial development promotes new measurements twins dyes expands the measurement data for regression analysis. In this article we give the parameters of the matrix (71 twins) for digital printing on polymer transparent foils.

The mathematical model is valid for an unlimited number of color tones. The model was used in the reports where it is used CMYKIR separation, but with different parameters in the matrix A. The values of the parameters in matrix A for offset CMYK printing on coated paper is publish in a work that shows the printing of postage stamps with dual image (J. Žiljak Vujić et al, 2014).

Explanation of a 1, 2, 3 is connection and mutual influence of process colors. These relationships are repair of general equations in CMYKIR separation. It applies to the presence of dyes and processing each C, M,, Y color but the coverage for greater than 33%. This allows the replacement of these dyes with black dye by setting GCR procedure replacement process dyes with the black. This model assumes the appearance of all parts of the IR graphics equally.

Digital printing has a well-maintained registry of overlapping colors. In security printing are running thin lines with process dyes which are spaced from each other sufficiently small that the human eye does not see separately.

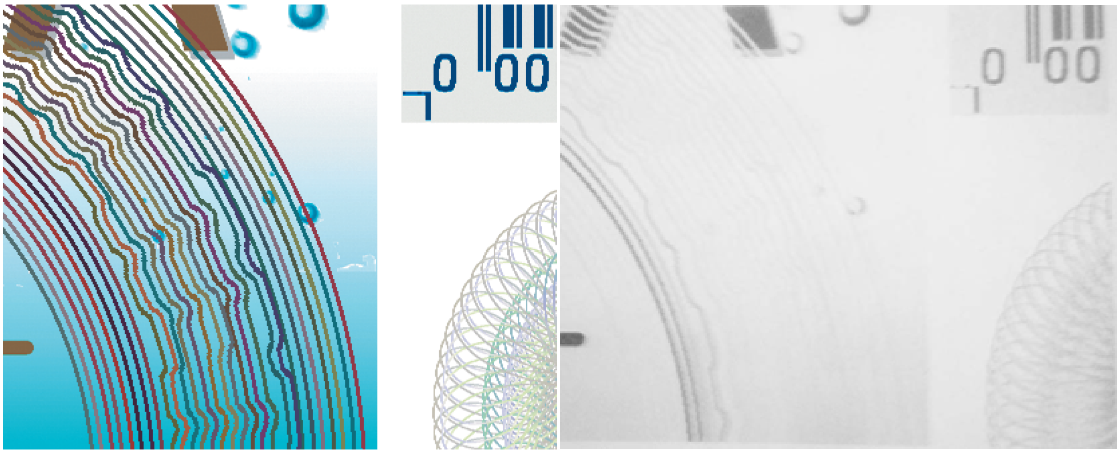

Figure 1. Part of the IRD line graphics in the visual and in Z (1000 nm) spectrum

3 Design with clear knee-line graphics

We expand CMYKIR separation at the junction of line color graphics, bar codes and the main image which is a design with hidden information on packaged product.

The paper demonstrates the process and the solution of complex design that includes a picture of the label with obligatory information about the product, breaking the data on visual and infrared data set system INFRAREDESIGN, multicolor line graphics with information "GRAFIČKI FAKULTET", and algorithm for interdependence of twins color. The first stage of the design is the choice of colors randomly in the line graphic. To each line it is assigned a color generated from the RGB system. In the second step parameters are added to twin colors for V and Z range with the controlled own properties of graphics in the visual and infrared spectrum (V. Žiljak et al, 2012).

Bar code is designed in blue that appears in the visual and infrared spectrum. In this way, the bar code is available and readable in the two spectra, depending on the cameras, viewing conditions and the variety of designs Barcode reader. Filter in the RGB camera is set to the high contrast of gray tones in the NIR spectrum. The difference between recording and reading Z spectrogram is set to double the size of the benefit of Z camera.

In Figure 2 is the overall design with different graphics solutions in the visual and infrared spectrum (Figure 2 and 3). Connect the line prints and general design of the label is deliberately solutions as the possibility of extending the transparency of drawings on transparent polypropylene material.

All graphics, colors and dyes are planned and then carried out on the polymer material with digital print. Individualized features are the words: „FAKULTET" in a circular form to the right and „GRAFIČKI" on the left side of the knee line graphics designed as a circular extrapolation line graphs.

In this paper, we demonstrate the creation of the knee line graphs and its curvature. Linearized text of process safety design (J. Žiljak Vujić et al, 2014) has a knee lines that its slope (knee) are achieved in that place greater coverage. Changing the direction of advancement set lines is creating greater coverage and thus enhances the edges of the image pixel elements (J. Žiljak Vujić et al, 2014). Line graphics are converted to vector graphics and prepress preparation for further processing in programs as "Illustrator", "Freehand" or "InDesign." PostScript allows recording and two graphics, vector and pixel, on the same document, which is an advantage for the transition to further typographic treatment. Such an algorithm can be interpreted with different ways of writing. It may remain as double information in the .PDF format, or only in the form of a pixel graphic as a .TIF record at very high resolution.

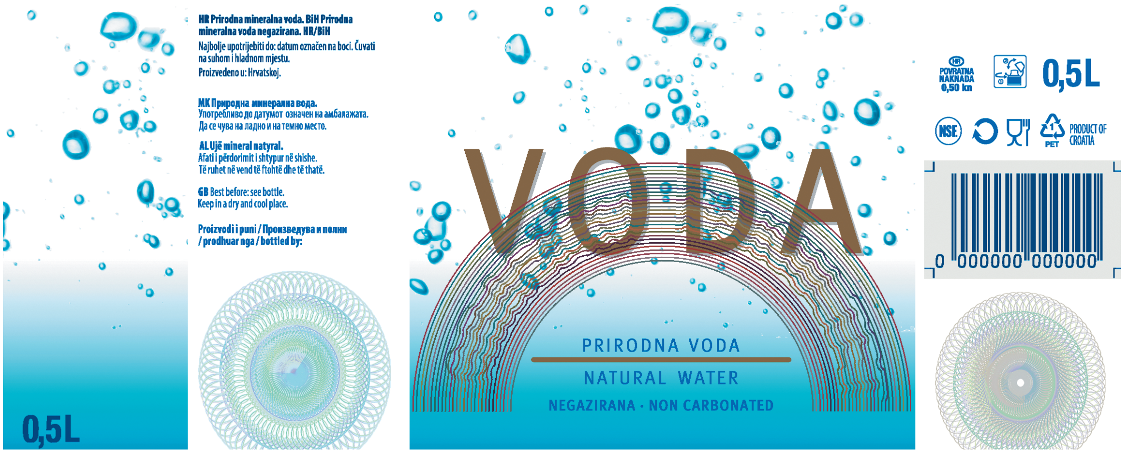

Figure 2. The design of the visual and infrared graphics

Graphical elements are marked with numbers one to eight. We look at them with ZRGB cameras (J. Žiljak Vujić et al, 2014) resulting in a picture Z, which is planned for the IR spectrum. Graphic under No 2 is the title of the label: VODA. This graphic can be seen in the IR light. In visual light is brown as the line below, between the two texts. Over titles VODA exceeds line graphics with higher priority visibility. Circular line graphics (annotated as 1) consists of 28 alternating colored lines with angular marks text "GRAFIČKI FAKULTET". Line graphics is filled only 37.5% since the goal was to perform transparency of the label. Lines 6 to 9 have different positive Z value (V. Žiljak et al, 2011). These lines are shown in the Z spectrum. The other lines are not seen in the IR spectrum. They go over all other parts of graphics with the highest priority. Therefore, these lines are shown as white lines in IR light, especially emphasized at points where it appears the title of the label VODA. The plan of IRD design is shown in Figure 2 visually and in Figure 3 infrared state. Label design has two rosettes. They are equally colored twins with blue tone (Figure 4), but differ in the V / Z spectrum. Rosette, marked with number 3, is not visible in IR camera while the rosette number 4 is seen in the NIR spectrum.

*Table 1. The values of L*a*b, Z (1000 nm) in IRD label design „VODA"*

Mark on the picture		L*a*b	Z on 1000 / 850 nm	Simulation with CMYK toner
from 1 to 5 and from 10 to 28	lines:	different	0,06	x
1	6. line	17, 17, -7	0,13 / 0,20	77,90, 64,38
	7. line	18, 22, -11	0,12 / 0,16	78,95,60,29
	8. line	32, 30, 6	0,12 / 0,13	57, 87, 71, 11
	9. line	38, -7, 23	0,10 / 0, 13	68, 58, 93, 14
2 brown	VODA	45, 7, 24	0,18 / 0.27	0, 27, 50, 57
3	rosette 1	different	0,06	x
4	rosette 2	different	x	x
5 blue Z	0,5L	29, 1, -32	0,14 / 0,19	96, 66, 0, 40
6 blue V	0,5L	29, 1, -35	0,06	98, 79, 28, 0
7 blue Z	text	29, 1, -32	0,14 / 0,19	Z twin
8 blue Z	Bar cod	29, 1, -32	0,14 / 0,19	Z twin
9 blue V	texts	29, 1, -32	0,06	V twin

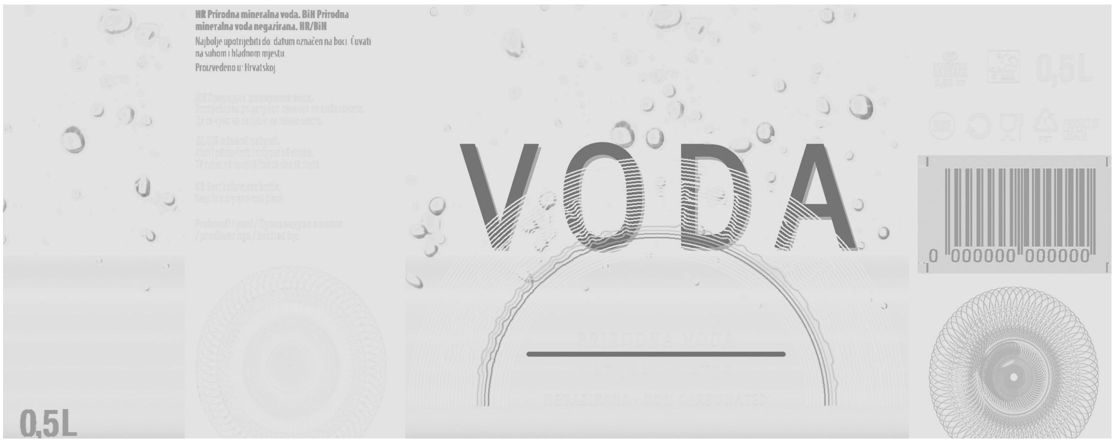

Fig.3 planned Z spectrum of label VODA at 850 nm

Blue color is designed as a twin colors and dyes marked as examples 1 to 9. These are the texts and bar code. Data, "0.5L" indicates the amount of water and appears in two ways as V (only visual) and Z domain. This mark, number 5, it can be seen from the IR camera, while the same label, as number 6, you can not see with the IR camera. Text at the number 7 is designed as a Z graphics. It is similar with a bar code which is designed as a twin Z blue. He can be seen in both spectrum: visual and infrared. Text „PRIRODNA VODA" is designed as a V graphics.

Printing with a digital printer OKI is a simulation of mass printing with spot dyes. These values are given in Table 1 as the CMYK values.

4 The Spectral properties of the dyes on the label „VODA"

The biggest difference in the Z state of the print is at 850 nm. Therefore, Figure 3 is recorded in the barrier. Figure 3 is a barrier in on Z value of 1000 nm.

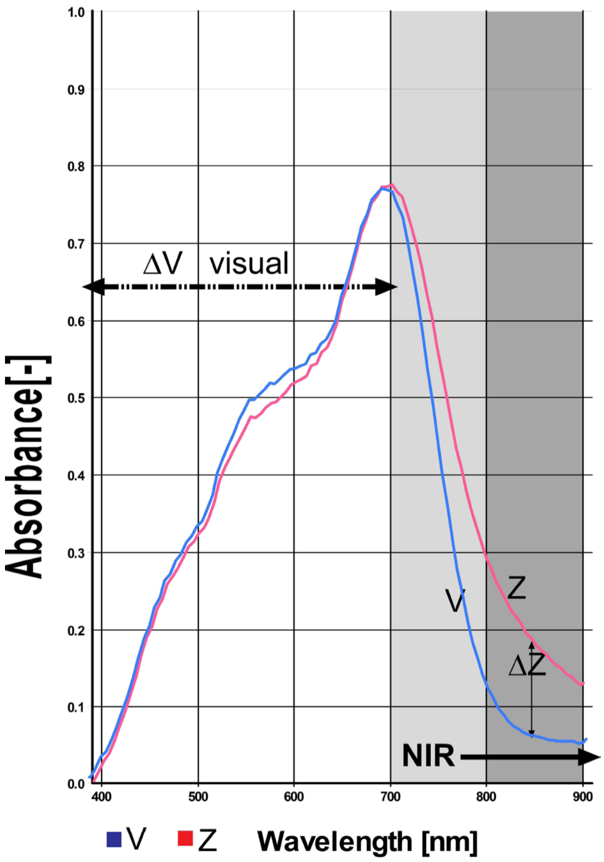

Figure 4. The spectral curves of blue twins tones in the V and Z dyes composition

The spectrum of blue tones shows different states in the infrared part, that is recording with the ZRGB camera (J. Žiljak Vujić et al, 2014). After a number of iterations of reproduction, measurement (REPORT <3) and the graphic display, it was succeed to achieve equality of colorants in the visual spectrum which shows the V and Z graphs in area from 400 to 700 nm. The colorimetric L*a*b values and spectrograms are derived with the forensic instrument Projectina (Projectina Docucenter 4500). For all dyes on label "VODA" were spectrograms were displayed. This may be a basis in the steps of printing repetitions the same label. Table 1 gives colorimetric L*a*b values.

5 Conclusions

Label design on a transparent material is planned in two spectral regions. Dyes given new size of its composition and differ as: L*a*b – V; and L*a*b – Z: Equality in the visual spectrum (L * a * b) the difference in the Z range. Mixing these dyes is very difficult and time-consuming process if the goal is to achieve a given Z value. Today suppliers of dyes, have no such a recipe and research in this area is in inception phase. The simulation of spot colors in two V and Z states were determined using process CMYK components on a white background. This procedure reduces the number of iterations to achieve recipes for spot dyes in large print edition. The graphics on transparent materials is solved with "transparent" line, vector descriptions and lower values of raster coverage. Different graphic elements overlap intentionally. This will disable scanning procedures path to unwanted reproduction. INFRAREDESIGN is used in two ways. Twins colors that allow selective exemption of information and graphics performance with more or less Z characteristics. These modes are planned as security printing.

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