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COMPARATIVE ANALYSIS OF LABELS PERFORMED BY FLEXOGRAPHIC AND ELECTROGRAPHIC MACHINES

ANALIZA PORÓWNAWCZA ETYKIET WYKONANYCH ZA POMOCĄ MASZYN: FLEKSOGRAFICZNEJ I ELEKTROFOTOGRAFICZNEJ

ABSTRACT: In the present paper, the issued connected with two printing technologies in aspect of label printing, were discussed. The main aim of the studies was to compare the copies, obtained from the flexographic machine and from digital machine, utilizing the phenomenon of electrophotography. The comparative analysis was based, first of all, upon the colouristic aspects but other parameters concerning the final copies and the process of their production was considered.
To perform the prints, the following machines were used: Digital Pro 3 and flexographic Performance Series 5 by Mark Andy company. As substrate, the standard self-sticking paper MC FSC S2000NG-BG40BR was used; it is one of the most popular substrates employed in production of labels. The assessment of the copies was carried out on the basis of s special printing test, using spectrophotometer X-Rite eXact.
The digital and flexographic copies were subjected to visual evaluation as well as spectrophotometric and densitometric measurements. Foe the produced copies, the following parameters were determined: optical density, reproduction of colours, gamut, balance of greyness, relative contrast, trapping, reproduction of small elements, and errors of the process.
On the grounds of the obtained data, the diagrams were prepared and the respective calculations were carried out. The analysis of the measurement results allows concluding that the digital machine, which employs the phenomenon of electrophotography as well as flexographic equipment are very well adapted to label printing. The both discussed devices possess certain defects and advantages; therefore, the choice of machine for printing should be carried out in relation to the defined work and in accordance to the expectations. In summing up, the criteria of the choice were determined and the comparison of the employed techniques was carried out..
Key words: digital printing, flexography, optical density, gamut, printing quality, paper

STRESZCZENIE: W niniejszym artykule poruszane są zagadnienia związane z dwiema technologiami drukowania w odniesieniu do produkcji etykiet. Głównym celem badań jest porównanie odbitek uzyskanych za pomocą maszyny fleksograficznej oraz cyfrowej wykorzystującej zjawisko elektrofotografii. Analiza porównawcza opiera się przede wszystkim na aspektach kolorystycznych, ale rozpatrywane są również inne parametry dotyczące gotowych wydruków, jak i procesu ich produkcji.
Do wykonania wydruków zastosowano maszyny: cyfrową Digital Pro 3 oraz fleksograficzną Performance Series P5 firmy Mark Andy. Jako podłoże użyto papieru standardowego samoprzylepnego MC FSC S2000NG-BG40BR, który jest jednym z najpopularniejszych podłoży wykorzystywanych do produkcji etykiet. Oceny odbitek dokonano na podstawie specjalnego testu druku przy użyciu spektrofotometru X-Rite eXact.
Wydruki cyfrowe i fleksograficzne zostały poddane ocenie wizualnej jak również pomiarom spektrofotometrycznym i densytometrycznym. Dla wykonanych odbitek zbadano następujące parametry: gęstość optyczna, odwzorowanie barw, gamut, balans szarości, kontrast względny, trapping, odwzorowanie drobnych elementów, błędy procesu.
Na podstawie uzyskanych danych utworzono wykresy i dokonano odpowiednich obliczeń. Po analizie wyników pomiarów wywnioskowano, że zarówno maszyna cyfrowa wykorzystująca zjawisko elektrofotografii jak i fleksograficzna są bardzo dobrze przystosowane do drukowania etykiet. Oba urządzenia posiadają pewne wady i zalety, dlatego wyboru maszyny do drukowania należy dokonywać dla konkretnej pracy oraz w zależności od oczekiwań. W podsumowaniu określono kryteria wyboru i dokonano porównania wykorzystanych technik.
Słowa kluczowe: druk cyfrowy, fleksografia, gęstość optyczna, gamut, jakość drukowania, papier

INTRODUCTION

Sector of labels has currently become one of the most rapidly developing and growing sectors of economy [1]. The producers are constantly improving labelling of the products with the aim to attract constantly the attention of potential consumers what, in consequence, means higher sale.

Nowadays, the labels may be produced practically by any printing technique (see: Fig.1). One of the most popular methods of creating the label includes flexography and digital technologies, including electrography. The choice of the appropriate printing technology is very important aspect of production planning. It requires analysis of many factors and

variables. Depending on the order, we should make the assessment of available printing methods in respect of *inter alia*, type of the material to be printed, durability of print on a given substrate, the employed improvements or colour expectations.

At present, printing sector in segment of labels and packaging is found at the beginning of digital revolution. The number of installations of digital machines for printing of labels and flexible packaging during the recent years has become higher than the quantity of installations of traditional equipment. Also, the application of hybrid printing machines which combine few printing techniques has been very popular. At such situation, we may combine some classical methods or traditional printing and digital technologies in one device [2].

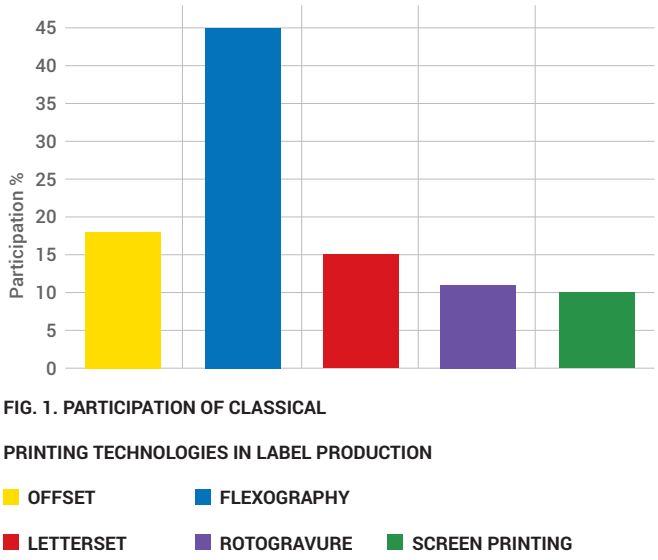

FIG. 1. PARTICIPATION OF CLASSICAL PRINTING TECHNOLOGIES IN LABEL PRODUCTION

THE AIM OF THE STUDIES

The aim of the studies was to compare the copies, obtained from flexographic machine and digital machine, utilizing the phenomenon of electrophotography. The comparative analysis is based, first of all, upon the colouristic aspects but other parameters concerning the ready prints and the process of their production are taken into consideration, as well.

To perform the prints, the following machines were used: Digital Pro 3 and flexographic Performance Series 5 by Mark Andy company. As substrate (background), standard self-sticking paper MC FSC S2000NG-BG40BR was used; it is one of the most popular substrates employed in production of labels. The assessment of the copies was carried out on the basis of special printing test, using spectrophotometer X-Rite eXact.

OPTICAL DENSITY

Optical density on the copy is closely connected with the amount of laid ink and is dependent on many factors during printing process. [3].

The measurement of optical density of the colour range CMYK was performed using field no 1 of the first page of the test. Then, standard deviation of the obtained results was calculated. The measured values of optical densities of full fields are higher in the case of flexographic copy for all primary colours what

TAB. 1. OPTICAL DENSITIES OF FULL FIELDS CMYK ON THE GROUNDS OF MEASUREMENT OF FIELD NO 1 AT P.1 OF THE TEST

Copy	DIGITAL COPY				FLEXOGRAPHIC COPY			
Colour	**C**	**M**	**Y**	**K**	**C**	**M**	**Y**	**K**
Optical density values	1,37	1,56	1,04	1,56	1,89	1,64	1,36	1,85
	1,36	1,50	1,03	1,61	1,89	1,60	1,35	1,86
	1,36	1,51	1,03	1,60	1,90	1,62	1,35	1,83
	1,38	1,56	1,04	1,56	1,90	1,65	1,36	1,82
	1,34	1,58	1,05	1,59	1,85	1,60	1,35	1,86
	1,41	1,53	1,05	1,66	1,89	1,64	1,34	1,84
	1,39	1,57	1,04	1,60	1,91	1,62	1,35	1,85
Mean	**1,37**	**1,54**	**1,04**	**1,60**	**1,89**	**1,62**	**1,35**	**1,84**
Deviation	±0,02	±0,03	±0,01	±0,03	±0,02	±0,02	±0,01	±0,02

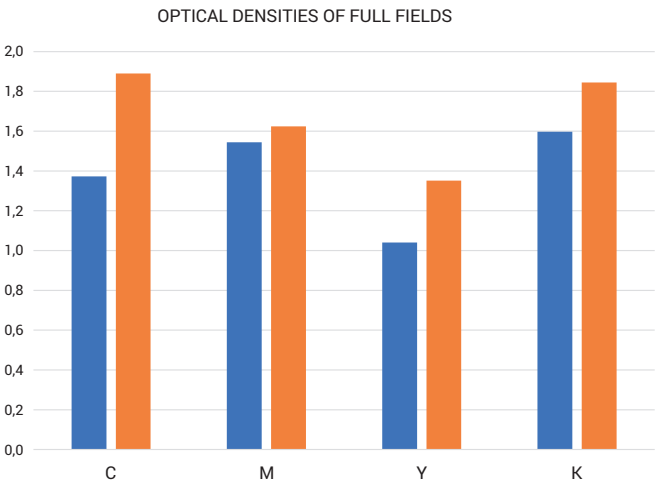

FIG. 2. COMPARISON OF OPTICAL DENSITIES OF FULL FIELDS CMYK FOR DIGITAL AND FLEXOGRAPHIC PRINTED COPY

DIGITAL COPY **FLEXOGRAPHIC COPY**

may be noticed in Fig.2. The lowest values of optical density were found for the fields printed with yellow colour for digital as well as for flexographic copy. Standard deviations are low for all CMYL colours. The lowest value of standard deviation was demonstrated by yellow colour for the both digital and flexographic copy.

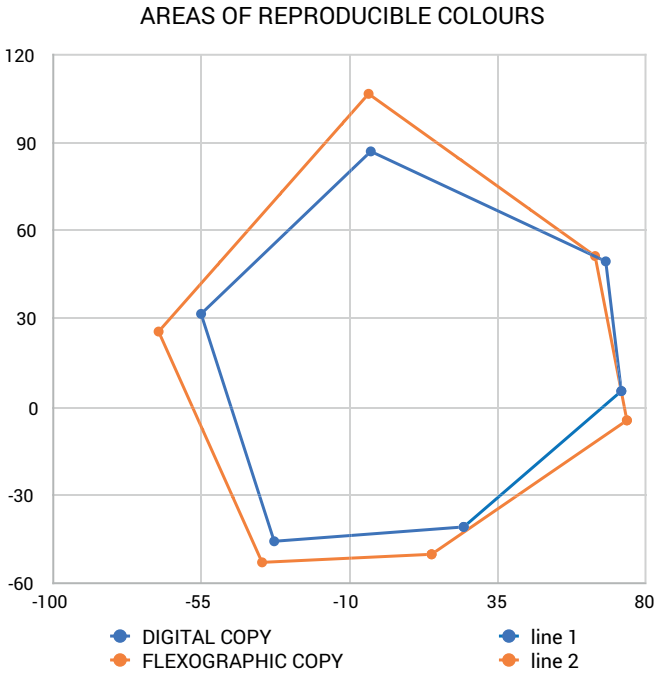

FIG. 3. COMPARISON OF REPRODUCIBLE COLOUR AREAS FOR DIGITAL MACHINE AND FLEXOGRAPHIC MACHINE ON THE GROUNDS OF COORDINATES A* AND B*

REPRODUCTION OF COLOURS

The quality of colour reproduction on the copy may be evaluated using coordinates L*a*b*, creating three-dimensional space of colours CIE Lab. The coordinate L* means brightness of colour. The coordinate a* characterizes participation of colours from green to red whereas the coordinate b* determines the colour from blue to yellow [4].

Each background of CMYK and RBG colours was measured in three sites alongside the printing direction (see; Tab. 3)

The data contained in Tab. 3 indicate the stability of printing process in the digital as well as in the flexographic machine. The measurements for the both mentioned technologies are coherent for all colours CMYK and RGB.

On the grounds of the measured coordinates, the difference in colours for the particular colours between the digital and flexographic copy was calculated with the application of the following formula: $\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$

The results are given in Tab. 4.

The colour differences between the digital and flexographic copy are high. The greatest difference occurs in the case of componential Y and colour G which contains this componential. It affected, first of all, by the coordinate b* of yellow colour which is considerably higher in flexographic copy. It means that for printing in flexographic machine, the mentioned colour is more yellow whereas in the case of digital machine, it makes the impression of lightly blue. On the other hand, for componential C and M, parameter b* is higher for digital copy. In the case of componential K, it has a higher componential L* on digital print, i.e. greater brightness.

The measurements of coordinates L*a*b* served for determination of the areas of reproducible colours of the machines, the so-called gamut (the complete subset of colours). The mentioned areas have a shape of hexagons the tops of which are created by marking – in system a*b* - the values for the particular colours in sequence MRYGCB. Black colour is omitted as it is dependent only on the coordinate L*, meaning brightness.

TAB. 2. COORDINATES L*A*B* OF THE OVERPRINTED SUBSTRATE

Measured values			Values according to standard (norm)			Difference of colour	
L	a	b	L	a	b	ΔE	Mean
91,98	0,80	-1,45				2,02	
92,14	0,67	-1,22				2,09	
92,08	0,77	-1,37				2,02	
92,44	0,62	-1,07	**93,00** ± 3,00	**0,00** ± 2,00	**-3,00** ± 2,00	2,10	**2,12**
92,51	0,60	-0,82				2,31	
92,49	0,59	-0,93				2,21	
92,59	0,65	-1,08				2,07	

TAB.3. COORDINATES L*A*B* OF FIELDS CMYK AND RBG FOR DIGITAL AND FLEXOGRAPHIC COPY ON THE BASIS OF PAGE 2 OF THE TEST

Copy	DIGITAL COPY			FLEXOGRAPHIC COPY		
Values	L	a	b	L	a	b
C	51,51	-31,73	-45,62	50,70	-36,79	-52,13
	50,33	-32,81	-45,80	49,42	-36,95	-52,15
	51,47	-31,78	-44,46	49,42	-36,48	-52,98
M	43,92	72,42	5,36	46,66	74,03	-4,66
	43,22	72,16	4,10	45,92	72,67	-4,87
	2,84	71,80	4,50	46,69	74,11	-4,61
Y	84,25	-3,53	87,00	86,99	-4,57	105,51
	84,36	-4,08	86,82	86,81	-4,33	106,27
	84,03	-3,84	86,53	86,74	-4,20	106,61
K	19,11	-0,43	-0,33	10,10	0,75	1,74
	19,94	-0,44	-0,57	9,37	0,64	1,41
	19,39	-0,42	-0,37	9,48	0,70	1,35
R	43,73	66,45	47,55	47,33	64,47	51,35
	42,51	65,85	47,25	47,34	64,48	51,29
	43,02	67,70	49,54	47,52	64,66	49,33
G	50,73	-54,00	31,12	42,39	-67,85	25,63
	50,20	-54,51	31,37	42,14	-67,20	23,15
	50,62	-54,97	31,65	42,60	-67,12	21,99
B	25,08	24,05	-39,33	19,14	14,90	-50,23
	23,23	24,45	-39,82	19,03	14,55	-50,07
	24,64	24,65	-40,91	19,92	13,72	-49,52

TAB. 4. COLOUR DIFFERENCES CMYL AND RGB FOR DIGITAL AND FLEXOGRAPHIC COPY

Colour	Difference of parameters						Difference of colours	
	ΔL	Mean	Δa	Mean	Δb	Mean	ΔE	Mean
C	0,81	1,26	5,06	4,63	6,51	7,13	8,28	**8,62**
	0,91		4,14		6,35		7,63	
	2,05		4,70		8,52		9,94	
M	2,74	3,10	1,61	1,48	10,02	9,37	10,51	**10,02**
	2,70		0,51		8,97		9,38	
	3,85		2,31		9,11		10,16	
Y	2,74	2,63	1,04	0,55	18,51	19,35	18,74	**19,54**
	2,45		0,25		19,45		19,61	
	2,71		0,36		20,08		20,27	
K	9,01	9,83	1,18	1,13	2,07	1,92	9,32	**10,08**
	10,57		1,08		1,98		10,81	
	9,91		1,12		1,72		10,12	
R	3,60	4,31	1,98	2,13	3,80	2,68	5,60	**5,83**
	4,83		1,37		4,04		6,44	
	4,50		3,04		0,21		5,43	
G	8,34	8,14	13,85	12,90	5,49	7,79	17,07	**17,23**
	8,06		12,69		8,22		17,13	
	8,02		12,15		9,66		17,47	
B	5,94	4,95	9,15	9,99	10,90	9,92	15,42	**14,99**
	4,20		9,90		10,25		14,86	
	4,72		10,93		8,61		14,69	

Flexographic copy is characterized by greater area of reproducible colours as compared to digital copy. As regards red colour, curves for the both copies are similar. For the remaining areas, the tops of the hexagon, limiting the range of the reproducible colours of flexographic machine are more distant from the middle of coordinates' system. It means that yellow, green and blue colours are more differentiated in the case of flexographic copy.

BALANCE OF GREYNESS

The name of the greyness balance is defined as combination of componential elements CMY which create a colour on a copy that is mostly approximate to greyness resulting due to the application of solely black paint with a given degree of coverage. To this end, there were measured the coordinates L*a*b* for chromatic fields, simulating printing with the black ink at the level of 25%, 50% and 75%. The obtained values have been presented in Tab.6.

The flexographic copy shows greater chromaticity of greyness fields. Coordinate b* is considerably more deviated from zero as compared to digital copy. The measured data indicate that the greyness fields of flexographic copy have a yellow shade what is suggested by high values of coordinate b*. The digital copy is characterized by a colour more approximate to achromatic overprint as coordinates a* and b* are near zero. For field of 75% coverage, the flexographic copy shows low negative values of coordinate a*, i.e. it acquires green shade.

There was determined the difference of colours for the greyness fields in the case of digital and flexographic copy (Tab.7).

The differences of colours for all fields are equal to ca. 10. It is a relatively high value what is affected by, first of all, difference in b* coordinates. Brightness of greyness fields is similar for the both copies.

The quality of greyness balance was also visually assessed: in the case of digital copy, the greyscale, created from CMY colours resemble more grey, generated from the black colour. The chromaticity of greyness is more visible for flexographic copy; it is true especially for field of 25% coverage for which yellow colour is dominating, and for field of 75% coverage where the colour makes the impression of being slightly blue.

TAB. 5. THE SELECTED COORDINATES A* AND B* FOR DIGITAL AND FLEXOGRAPHIC COPY

Copy	DIGITAL COPY		FLEXOGRAHIC COPY	
Values	a	b	a	b
M	72,42	5,36	74,11	-4,61
R	67,70	49,54	64,47	51,35
Y	-3,53	87,00	-4,20	106,61
G	-54,97	31,65	-67,85	25,63
C	-32,81	-45,80	-36,48	-52,98
B	24,65	-40,91	14,90	-50,23

TAB.6. COORDINATES L*A*B* OF GREYNESS FIELDS FOR DIGITAL AND FLEXOGRAPHIC COPY

K	DIGITAL COPY			FLEXOGRAPHIC COPY		
	L	a	b	L	a	b
25%	71,58	0,69	-4,05	74,53	0,94	7,04
	71,59	0,63	-3,88	73,94	0,84	7,62
	71,45	0,18	-3,59	74,76	0,85	6,81
50%	55,69	1,59	-1,71	57,34	-0,69	8,24
	55,88	1,38	-0,74	57,62	-0,74	9,41
	55,58	0,72	-1,01	57,40	-0,81	7,74
75%	38,34	0,29	0,15	37,46	-6,33	8,57
	38,52	0,04	1,02	37,62	-7,14	10,26
	37,80	-0,33	0,26	37,82	-7,37	9,66

TAB.7. DIFFERENCE OF COLOURS OF GREYNESS FIELDS IN THE CASE OF DIGITAL AND FLEXOGRAPHIC COPY

Colour	Difference of parameters						Difference of colours	
	ΔL	Mean	Δa	Mean	Δb	Mean	ΔE	Mean
25%	2,95	2,87	0,25	0,38	11,09	11,00	11,48	**11,38**
	2,35		0,21		11,50		11,74	
	3,31		0,67		10,40		10,93	
50%	1,65	1,74	2,28	1,98	9,95	9,62	10,34	**9,97**
	1,74		2,12		10,15		10,51	
	1,82		1,53		8,75		9,07	
75%	0,88	0,60	6,62	6,95	8,42	9,02	10,75	**11,41**
	0,90		7,18		9,24		11,74	
	0,02		7,04		9,40		11,74	

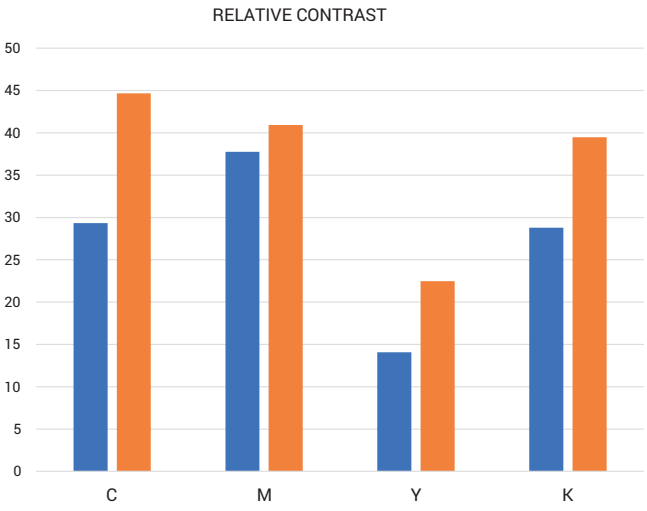

FIG.4. COMPARISON OF RELATIVE CONTRAST FOR DIGITAL AND FLEXOGRAPHIC COPY

DIGITAL COPY **FLEXOGRAPHIC COPY**

THE RELATIVE CONTRAST

The relative contrast is characterized by the reproduction of small elements in the shades for a defined colour. The optimum value of the relative contrast is estimated at more than 30%. It may be calculated using the following formula:

$$K_{WZ} = \frac{D_{100} - D_{75}}{D_{100}} \cdot 100\%$$

where:

D_{100} is the optical density of the field with 100% coverage,

D_{75} is the optical density of the filed with 75% coverage [5].

Values are given in Tab.8.

All the CMYK colours are characterized by a greater relative contrast in the case of flexographic copy what may be noticed

TAB. 8. VALUES OF RELATIVE CONTRAST OF CMYK FIELDS FOR DIGITAL AND FLEXOGRAPHIC COPY

Copy / Colour	DIGITAL COPY			FLEXOGRAPHIC COPY		
	Value	**Contrast**	**Mean**	**Value**	**Contrast**	**Mean**
C	1,35	29,30		1,97	52,90	
	1,34	28,60	**29.33**	1,96	51,90	**44.67**
	1,39	30,10		1,32	29,20	
M	1,50	36,60		1,50	42,30	
	1,51	38,40	**37.77**	1,49	42,30	**40.93**
	1,55	38,30		1,52	38,20	
Y	1,02	14,70		1,29	27,90	
	1,02	13,40	**14.07**	1,30	26,00	**22.47**
	1,05	14,10		1,02	13,50	
K	1,51	27,60		1,86	45,20	
	1,55	29,30	**28.80**	1,89	44,10	**39.47**
	1,55	29,50		1,54	29,10	

TAB. 9. TRAPPING VALUES FOR DIGITAL COPY

Copy	**DIGITAL COPY**								
Colour	**Y**	**M**	**Trapping**	**Y**	**C**	**Trapping**	**M**	**C**	**Trapping**
Values	0,96	1,44	88,40	0,96	1,24	77,50	1,44	1,24	69,90
	0,96	1,45	87,00	0,97	1,26	78,90	1,44	1,27	70,50
	0,96	1,46	87,00	0,96	1,24	77,60	1,44	1,25	69,30
Mean			**87.47**			**78.00**			**69.90**

in Fig.4. The smallest relative contrast both for the digital and flexographic copy was found for yellow colour. The remaining fields show the optimum relative contrast, therefore, the reproduction of details of the image on the both copies in shades may be defined as good.

TRAPPING

The conception of trapping is referred to printed sites where ink is laid down on the other. Trapping determines the ability of receiving the ink, transferred on the copy by the layer of ink which is already found on the substratum at the same site [3]. When determining trapping, the sequence of overprinted colours in significant. In printing on digital as well as flexographic machine, the colours were laid on the band in sequence from the brightest to the darkest, i.e. YMCK. The ink with Y colour is first overprinted on the substrate. Application of ink in M colour on the mentioned above colour, causes generation of R colour

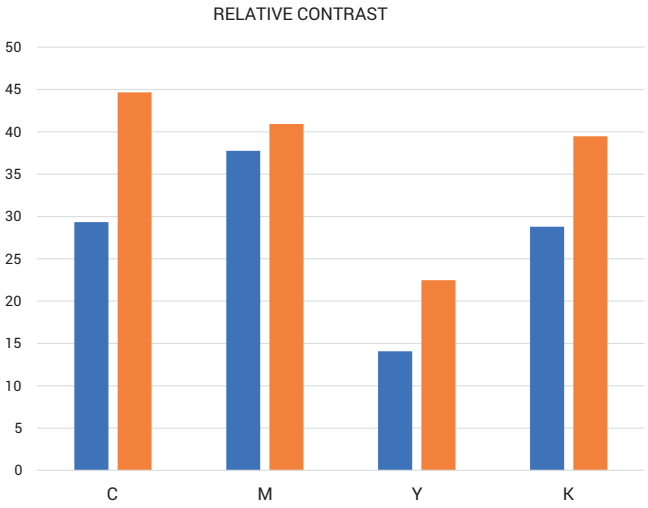

FIG. 5. COMPARISON OF TRAPPING IN DIGITAL AND FLEXOGRAPHIC COPY

TAB. 10. TRAPPING VALUES FOR DIGITAL COPY ON THE GROUNDS OF FIELD NO 9 AT PAGE 3 OF THE TEST

Copy	FLEXOGRAPHIC COPY								
Colour	Y	M	Trapping	Y	C	Trapping	M	C	Trapping
Values	1,25	1,39	78,80	1,24	1,85	83,10	1,39	1,85	82,80
	1,24	1,39	78,70	1,24	1,86	82,50	1,39	1,85	82,60
	1,24	1,39	79,10	1,24	1,85	83,40	1,38	1,85	82,30
Mean			**78.87**			**83.00**			**82.57**

TAB. 11. VALUE OF TRAPPING FOR DIGITAL COPY

Copy	DIGITAL COPY								
Colour	Y	M	Trapping	Y	C	Trapping	M	C	Trapping
Values	0,96	1,44	88,10	0,95	1,26	77,20	1,43	1,28	67,70
	0,96	1,45	85,60	0,95	1,32	73,20	1,45	1,31	66,00
	0,93	1,42	85,40	0,96	1,32	73,30	1,47	1,33	67,50
	0,97	1,49	85,60	0,94	1,24	77,60	1,48	1,33	65,60
	0,94	1,47	86,40	0,96	1,34	72,80	1,50	1,34	66,40
	0,96	1,49	87,90	0,96	1,32	74,60	1,46	1,24	71,70
	0,96	1,48	84,90	0,97	1,33	73,20	1,47	1,29	67,20
Mean			**86.27**			**74.56**			**67.44**

TAB. 12. VALUE OF TRAPPING FOR DIGITAL COPY

Copy	FLEXOGRAPHIC COPY								
Colour	Y	M	Trapping	Y	C	Trapping	M	C	Trapping
Values	1,23	1,37	83,20	1,23	1,79	86,80	1,38	1,85	83,60
	1,25	1,38	81,90	1,25	1,81	87,00	1,38	1,80	84,40
	1,22	1,36	82,90	1,27	1,84	83,90	1,38	1,81	83,30
	1,25	1,39	81,10	1,22	1,86	84,40	1,35	1,82	82,40
	1,26	1,38	81,70	1,23	1,84	85,40	1,38	1,78	85,00
	1,25	1,39	80,40	1,24	1,77	87,50	1,38	1,79	85,60
	1,23	1,37	83,00	1,25	1,80	85,60	1,38	1,82	84,20
Mean			**82.03**			**85.80**			**84.07**

whereas overprinting C on Y results in obtaining G colour. Colour B is obtained via application of ink in C colour on M layer.

Trapping was determined for secondary colours RGB, resulting from overlapping of two componential CMYK elements (Tab.9 and 10).

The measured values of trapping are relatively high what means that the employed inks indicate a good capability of accepting another ink. For colour R, trapping is greater in the digital copy. G and B Colours show a greater percentage value of trapping in the flexographic copy (see: Tab.11 and 12).

In the case of digital copy, values of trapping are more differentiated for the individual RGB colours. In the flexographic copy, trapping is similar for all secondary colours. The acceptance of ink by another ink in the both discussed types of copies is relatively constant alongside the printing direction (see; Fig.6 and 7). The variations of the mentioned parameter are found within the limits ca. 5%.

REPRODUCTION OF SMALL ELEMENTS

We may observe a low quality of reproduction of small elements in the digital copy for resolution of 2 400 dpi and 4 800 dpi. The mentioned fields acquire a uniform grey colour. In turn, flexographic copy reproduces well the smallest elements. Very small details are noticeable even by eye for all examined resolutions.

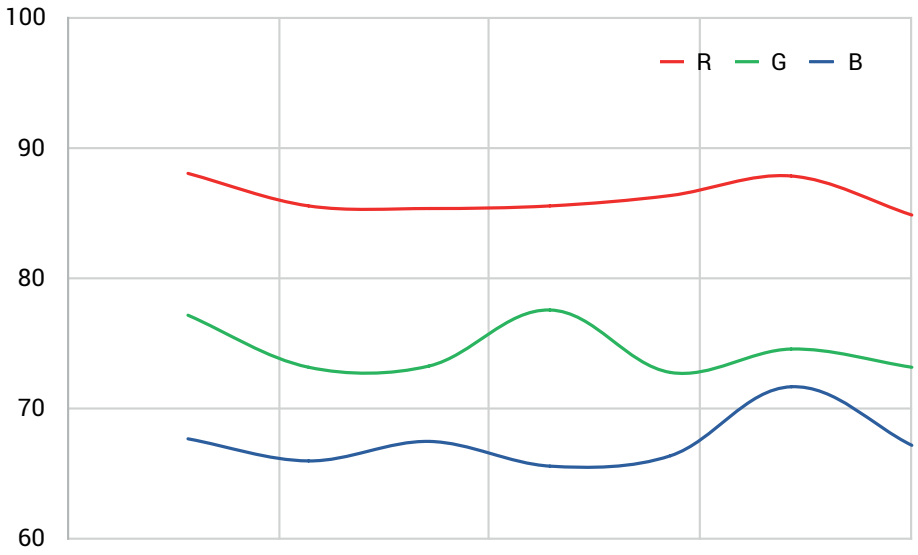

FIG. 6. RUN OF TRAPPING FOR DIGITAL COPY

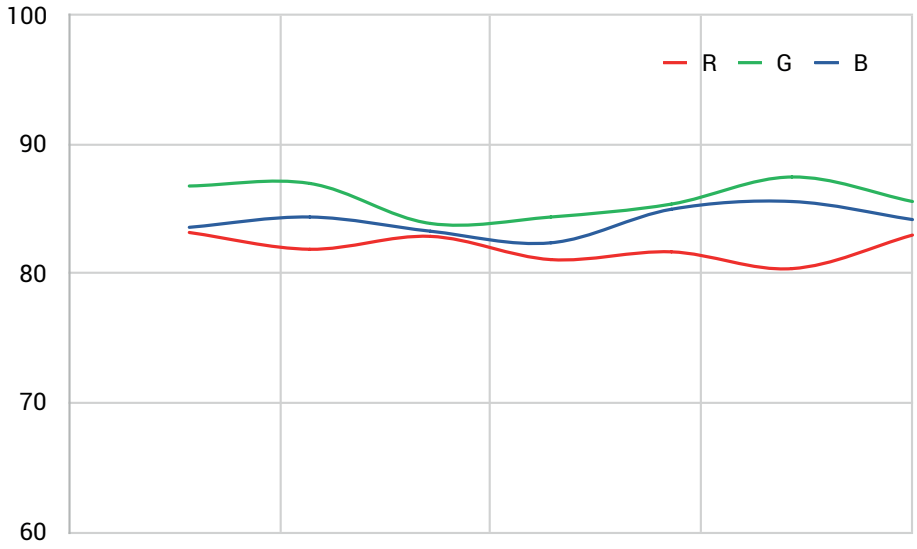

FIG. 7. RUN OF TRAPPING FOR FLEXOGRAPHIC COPY

TAB. 13. THE COMPARISON OF MACHINES: DIGITAL PRO 3 (DIGITAL) AND PERFORMANCE SERIES P5 (FLEXOGRAPHIC)

PROPERTY / MACHINE	DIGITAL	FLEXOGRAPHIC
Greater area of reproducible colours		+
Better reproduction of small elements		+
Better reproduction of greyness balance	+	
More „vivid" pictures	+	
Higher optical densities of full fields		+
Greater relative contrast		+
Greater trapping	It depends on the componential	It depends on the componential
Better reproduction of colours	It depends on the componential	It depends on the componential
Shorter preparation of materials to printing	+	
Shorter tool of machine	+	
More types of substrate		+
Greater number of improvement in machine		+
Possibility of slitting in machine	+	
Possibility of punching in machine	+	
Greater amount of spot colours		+
Higher speed of printing		+
Lower costs for small volume	+	
Lower costs for big volume		+
Possibility of printing on wider web		+
Possibility of printing on narrower web	+	

For digital copy, the dashes (bars) creating the figures become "ragged" at the level of 0.04 mm. For thickness of bars from 0.01 mm to 0.03 mm, they make the impression of having the equal thickness. On the other hand, in the case of the flexographic copy, the differences in the thickness are visible even for the thinnest dashes.

For the digital copy, the text of the size of 2 p becomes little readable. For 2 p, on the white background and for 3 p on the black background, the serif typeface is deprived of details. Already for 4 p, the difference in the thickness of the bars, forming the letters and figures is unnoticeable. The white text on the black background with the size of 1 p is impossible to be read out. In the case of flexographic copy, the text of the size of 1 p is possible to be read out under the magnifying glass both on the white and black background. In the case of the white text on the black background, the letters and figures of Times type of the size of 1 p, do not have any details.

THE ERRORS OF THE PROCESS

In the case of flexographic copy, the bright spots appear on the elements produced from componential K. Initially, it was believed that it was caused by contamination of printing mould. Cleaning of the mould has not eliminated the problem. It may mean that the reason for occurring printing mistakes is incorrectly exposed printing mould for the black colour.

The lines for yellow colour in the digital copy acquire undesired shapes. For the remaining colours at the level of 300 dpi, the errors in reproduction of the middle of circle and bright lines are found. It may indicate the smaller resolution of digital printing as compared to the flexographic printing.

CONCLUSIONS

The digital machine, which employs the phenomenon of electrophotography as well as the flexographic equipment are very well adapted to printing of labels. The both discussed devices possess certain defects and advantages, therefore the choice of machine for printing should be carried out for a defined work and according to the expectations. The basis criteria of the choice may be as follows:

– colouristic expectations,
– print volume ,
– format of work,
– number of colours,
– substrate,
– durability of print
– employed improvements.

On the grounds of the conducted studies, the comparison of the electrophotographic and flexographic technologies in relation to the employed machines has been carried out. The results have been given in Tab.13.

The conclusions coming from the coloristic aspects of the copies cannot be generalised and refer directly to the electrophotographic and flexographic technologies. The comparison concerns the defined machines, in which the printing was performed. Additionally, the results of the measurements were affected by many factors such as processes of preparation to printing, setting the machines, and also, properties of the employed materials. In the case of printing on flexographic machine, the reproduction of colour is dependent, inter alia, on the application or transfer curve. For flexographic copy, the "supporting" of minimal point was also performed what could affect the improvement of the print quality and better reproduction of small elements.

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