THE INFLUENCE OF THE STRUCTURE OF THE OFFSET RUBBER ON THE SCREEN REPRODUCTION

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Abstract:

During the indirect printing process, the rubber offset blanket has the function to transfer the ink from the printing form on the paper. The tiny printing elements of the dotted shape with the size between 20 and 250 μm (screen dots) are reproduced on prints. In this process, the positive deformation of the screen elements appear inevitably, which is in direct dependence on the hardness and the composition of the compressible rubber blanket. In this work it is analyzed how the rubber composition and its compressibility influence the reproduction of the screen elements, and how great is its influence in the total deformation of the screen elements. The shape of the reproduced screen elements, i.e. the circularity of the dots has also been monitored. All four printing units as well as their reproduction of the basic process inks have been tested in the work.

Key words: Offset printing, impressible rubber blanket, deformation of the screen elements, circularity,

1. Introduction

The principle of indirect printing has been used in offset lithography for the first time. Such principle is based on the prolonged ink transfer who starts from the printing form. Generally, the printing forms are composed of two kinds of elements: the non printing elements (they do not accept the ink but they accept the dampening solution) and the printing elements (they accept ink but they do not the dampening solution). The basic printing form for offset printing process is the aluminium plate whose surface is roughened and oxidized (non printing surfaces), while the printing elements were formed by selectively melting of previously coated photosensitive diazo layer (printing elements) [1].

The paste offset ink with its tackiness and density (dynamic coefficient of viscosity η= 40-150 Pa·s) is applied on the previously wetted printing form, adhering to the diazo layer. The rubber offset blanket (ROB) is the mediator in ink transfer and the dampening solution from the printing form on the printing substrate. In the contact of the printing form and the offset cylinder blanket, the first ink transfer happens during which the mirror image is formed on rubber. After that, the second ink transfer follows during which the ink is transferred on the printing substrate from the rubber offset blanket. The image is again turned and the right-reading impression is obtained whose applied ink thickness is between 0,5 – 1,5 µm. The forces in the contact zones of the cylinder are between 2,5 and 3 MPa [2].

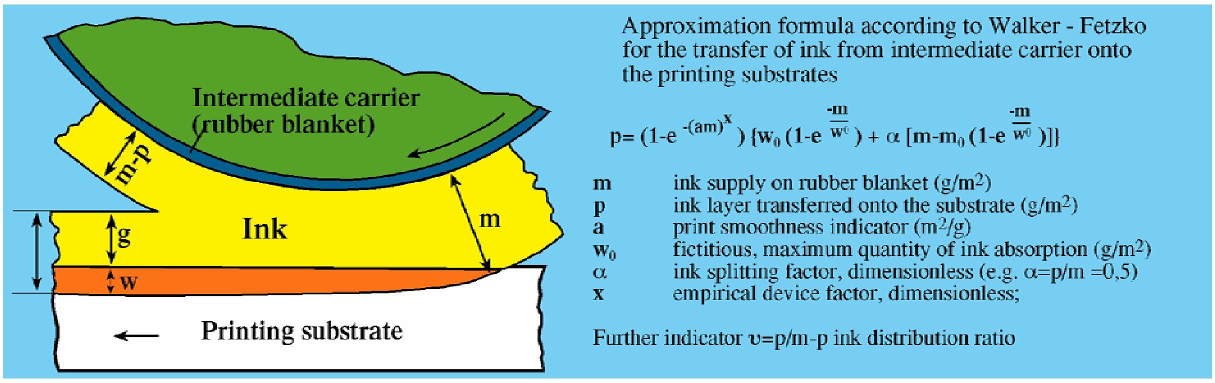

Figure 1. Printing ink transfer on the rubber offset rubber blanket, i.e. on the printing substrate

One of the factors influencing the quality of the multicolour reproduction is the composition of the offset cylinder dressing. In this work, the influence of its composition and hardness on the reproduction of the tiniest printing elements (screen dots) is analyzed.

2. Theoretical part

Offset cylinder is placed between thee printing and plate cylinder. It is composed of two parts: the productive part (it is in contact with the printing form, i.e. with the printing substrate) and the non productive part (it is not in contact with the printing form, i.e. with the printing substrate). In the non productive part there are two carriers of the offset rubber blanket which is tightened up by the tightening spindle. The production part of the offset cylinder has undercut (2,30 mm) in which the compressible i.e. non- compressible rubber blanket is placed. Because of its standard thickness (1,90 mm) the substrate is placed under the rubber offset blankets by which the total thickness is achieved which corresponds to the bearer height of the blanket cylinder (of the non compressible rubber blanket) while the total thickness in compressible blankets is for 0,05 mm higher than the bearer height [3].

Depending on the substrate composition (felt, papers, boards, rubber blanket) the tightened rubber offset blanket can have the hardness between 65° and 86° HS A. In the printing process under the influence of the same pressure, the compressible blankets will touch the printing form and the substrate in considerable longer contact zone than the conventional ones, and the print will have smaller deformations on that path. With greater hardness, the possibility of reproducing the tiniest screen elements is achieved (diameter of 8µm) with appearance of greater tribological wear [4].

Rubber offset blanket

ROB is composed of three or four layers of specially woven linen impregnated by elastomer mass and glue. The linen layers limit the elasticity of the ROB in order to extend it correctly and under control during stretching on the offset cylinder. The elastomer mass impregnated into the layers of linen determines the total hardness and deformability. The surface layer is produced by flattening especially prepared elastomer mass which is coated with the impregnated linen layers [5].

In recent times, under the surface and the first linen layer there is compressed layer of the cellular processed "spongy" polymer mass (0,03 – 0,05 mm). During the production it is formed so that the separated air or gas bubbles are blown into the hot polymer mass and compressed under pressure. The conventional linens realize the printing pressure by high elastic linen deformation in the whole thickness cross-section. The compressible surface layer deforms after to the printing form or substrate and the pressure is realized by compression of gasses in the compressible layer. Because of that reason, the conventional ROB is used only for printing on very smooth surfaces [6].

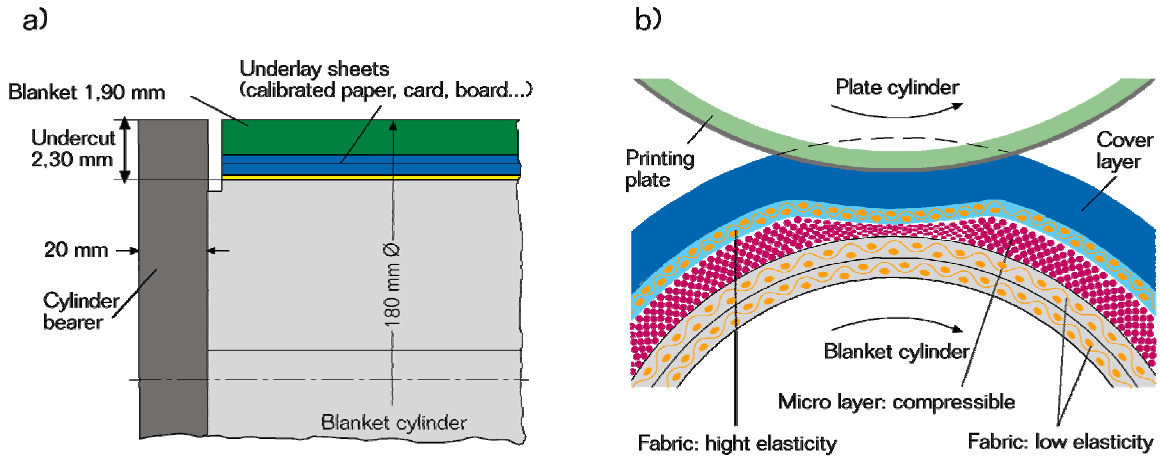

Figure 2. Cross section and deformations of the rubber offset blanket

Finally, ROB will have the direct influence on the future ink transfer, i.e. on printing appearances such as print edges deformations, doubling and extending of screen elements, picking and the angle of paper separation, mechanical deformations of paper, printing form wear, thickness and uniformity of the ink coating on the printing substrate [7].

3. Experimental part

Special printing form was made for this testing. Except the measuring and visual colour stripes there are greater CMYK patches on the form with the belonging color images. Standard fine art paper was used as the printing substrate with the grammage 115 g/m^2. Experimentally printed samples were obtained on four-colour offset printing machine Heidelberg Speedmaster 102, which prints in the following sequences KCMY (wet on wet printing). During the experiment 3 commercial types of rubber offset blankets were used: dyeGraphica 36, dyeGraphica 3000 and dyeGraphica 8213. Two basic structures were used: compressible structure and the non compressible one.

On the obtained prints, the characteristic screen patches were measured by spectrophotometer X-rite SwatchBook, which were presented as the function of the dot gain (Z%). With the device for the image analysis (Personal IAS) the increased image was obtained on which the dimension of the reproduced screen dots as well as their regularity (circularity) was measured [8].

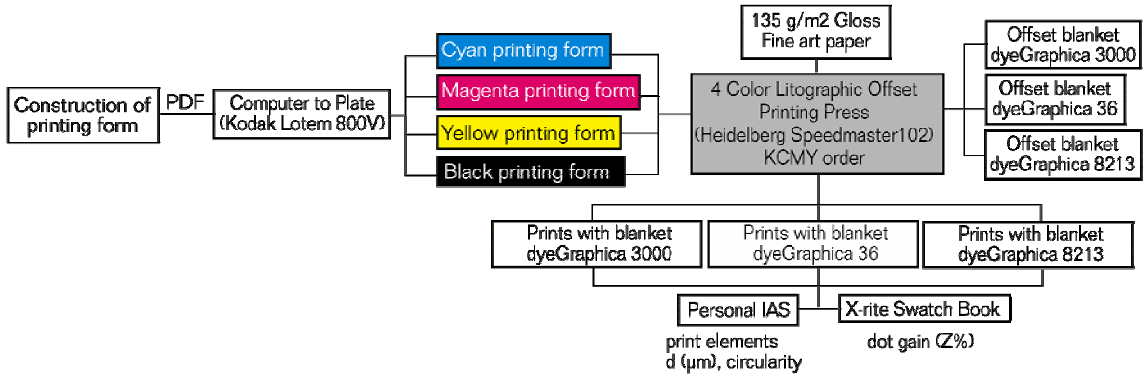

Figure 3. Schematic presentation of experiments

Table 1. Technical characteristics of the applied rubber offset blanket

Features:	dayGraphica 36	dayGraphica 3000	dayGraphica 8213
Type of blanket	compressible	compressible	uncompressible
Colour	Dark Blue	Dark Blue	Blue
Surface	Ground	Ground and Buffed	Ground
Thickness	4 Ply 1,96 mm	4 Ply 1,95 mm	3 Ply 1,95 mm
Face Compound	Solvent Reststant Rubber	Solvent Reststant Rubber	Solvent Reststant Rubber
Hardness	Overall 78° Shore A	Overall 78° Shore A	Overall 81° Shore A
Compressibility Deflection	0,220 mm at 2060 kpa	0,18 mm at 2060 kpa	0,10 mm at 2060 kpa
Elongation	1,1% at 10N/mm	0,9% at 10 N/mm	< 0,70% at 10N/mm
Tensile strength	91 N/mm	112 N/mm	> 60 N/mm

4. Results and discussion

The reproduction results of the screen values (halftones) , depending on the type of the rubber offset blanket, are presented in the form of dot gain Z (%).Only the process printing inks which were applied in printing wet on wet, were analyzed.

In all the graphs, the greatest dot gain is in the area between 40 and 60% of the screen value. In reproducing the black colour (the first printing unit) the greatest deformation of the screen elements appeared by the application of the rubber 36 ($Z_{50\%}$=17,5%), while the smallest one appeared when printing with the rubber 3000 ($Z_{60\%}$=15,5%). Both curves have similar shape which enabled the proportional tone reproduction. Black prints were made with the non-compressible rubber 8213 and have the maximal dot gain $Z_{60\%}$=17%. For the non-compressible rubber, the not sufficient dot gain in the area of 40% is characteristic, because the rubber has greater hardness which was achieved by smaller number of layers (3 layers). The dot gain curve follows the rubber gain curve 36 in darker areas (from 60% to 100% screen value) while in the lighter areas it follows the gain curve of rubber 3000.

In cyan printing (the second printing unit) the curves of the dot gain (Z%) are uniform on all tonal values. The exceptions are the compressible rubbers 36 and 3000 which form identical reproduction in the area of high tonal values. The greatest deformations appear in the area of 50%: $Z_{rubber36}$=18%, $Z_{rubber8213}$=15%, $Z_{rubber3000}$=11.5%.

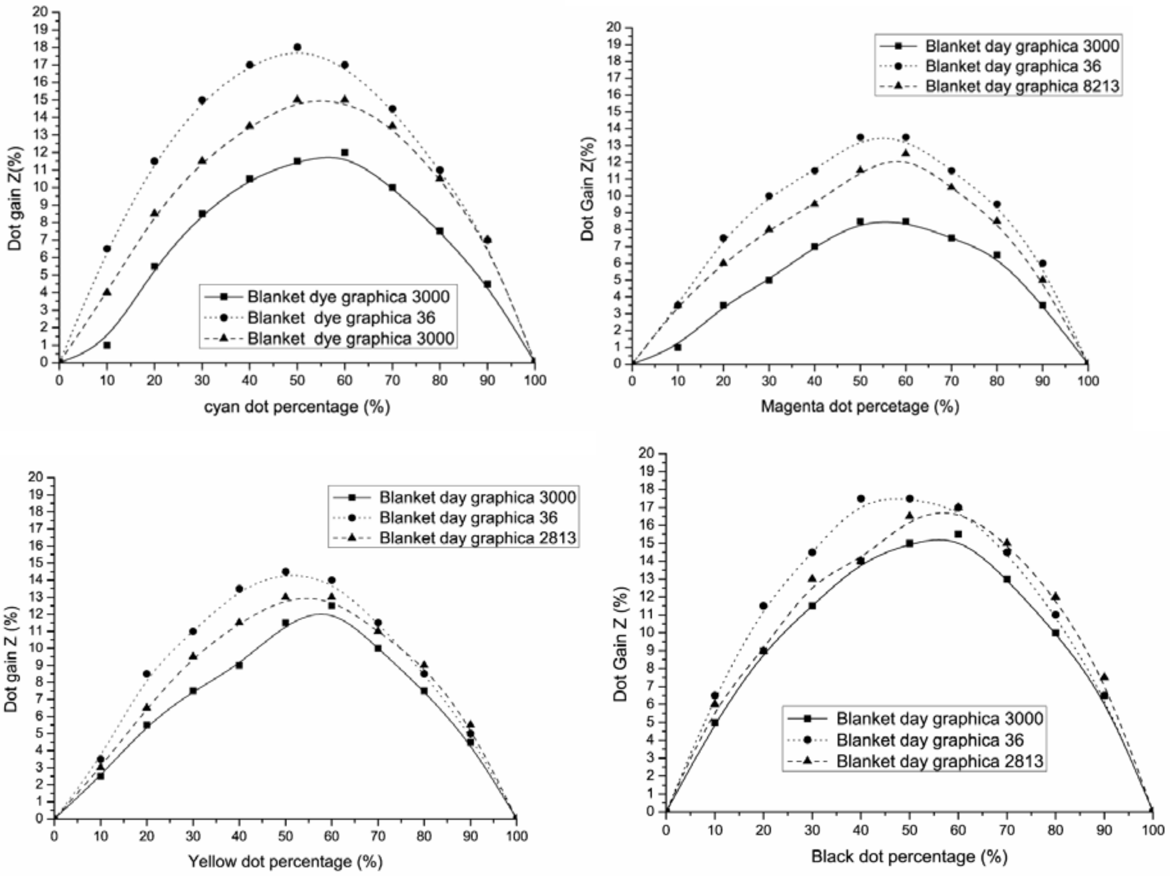

Figure 4. Dot gain on prints printed with rubber blankets dyeGraphia 36, dyeGraphia 3000, dyeGraphia 8213

The dot gain curves of magenta prints (the third printing unit) have similar shape as the curves of cyan prints. The difference is in the formed somewhat smaller maximal gains: $Z_{rubber36}$=13%, $Z_{rubber8213}$=12,5%, $Z_{rubber3000}$=8,5%.

On yellow prints (the fourth printing unit) with the different type of the rubber blanket, the greatest deviations in 40% screen area are formed: $Z_{rubber36}$=13,5%, $Z_{rubber8213}$=13%, $Z_{rubber3000}$=9,0%. With rubber 3000, the area of 40% tone value has insufficient gain. The compressible rubber 36, in comparison to the rubber 3000, has in its layers greater mechanical deformation which directly influences the dot gain.

Figure 4 presents how the tiniest image elements are reproduced, and how they are influenced by different structure of the offset rubber blanket. The dot gains in the area 10, 20 and 30% screen value are analyzed by IAS (figure 5)

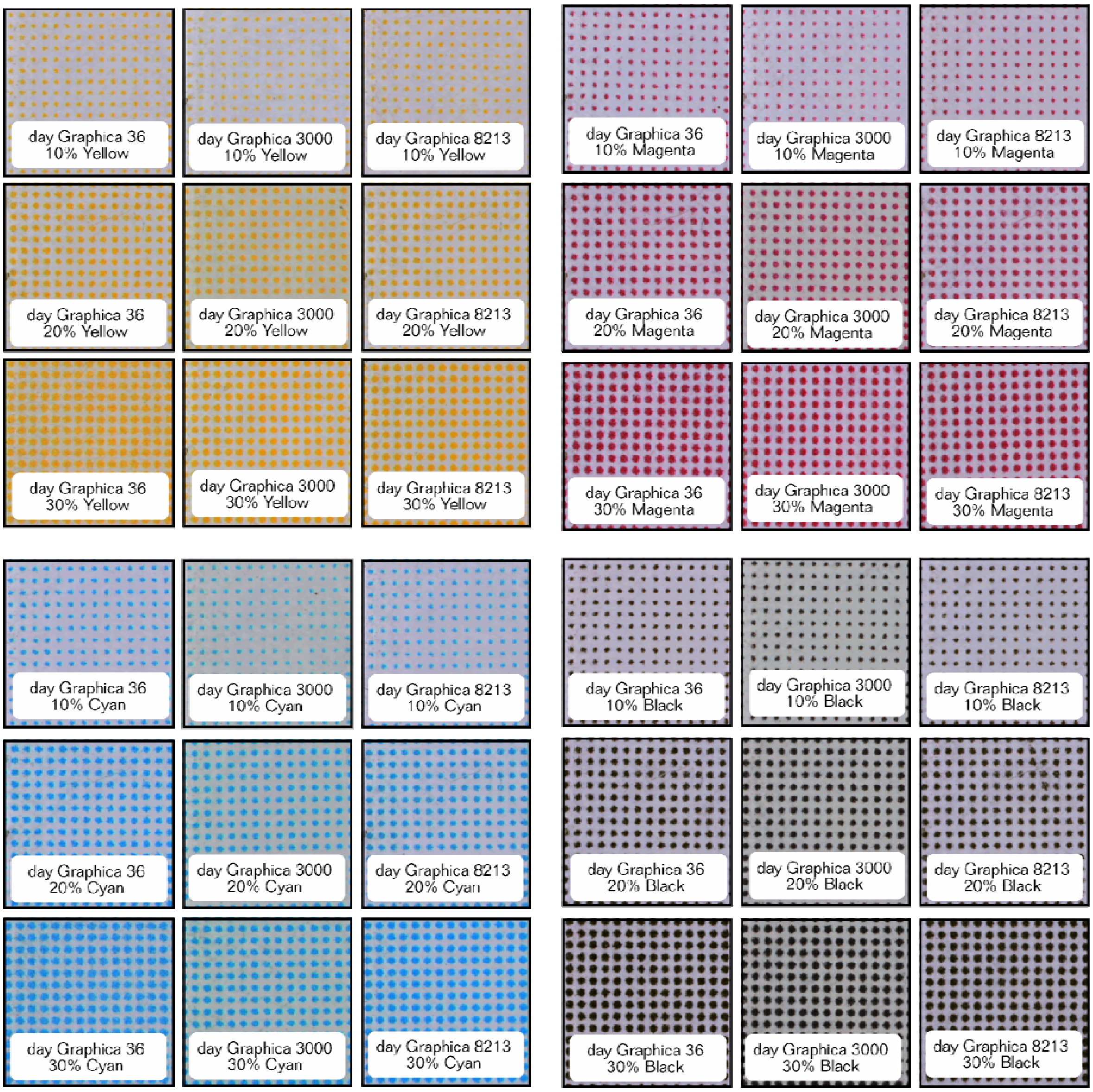

Figure 5: The magnified images of the analyzed samples printed with the rubbers dyegraphica 36, dyegraphica 3000 and dyegraphica 8213

It is generally valid for all the reproduced process inks, that the dependence of the screen value (of 10% and 30%) and the diameter of the printed elements (with different rubber blankets) is described as linear function.

The average reproduced cyan dots (for the areas 10, 20 and 30% screen value) have the greatest diameter d_{med}=91,44 μm (printed with the compressible rubber 36) while the smallest average diameter is obtained with the compressible rubber 3000 (d_{med}=80,15 μm). Non compressible rubber 8213 prints the average screen elements with the diameter d_{med}=83,42 μm and with its value it follows the linear curve of the rubber 3000. In the screen value of 30%, the deviation of the printed screen dots is the greatest. The characteristic curve of the rubber 3000 has the smallest deviation, which means that the dot gain stops to be linear ($\Delta d_{10\%-20\%}$=27,33 μm, $\Delta d_{20\%-30\%}$=15,83 μm).

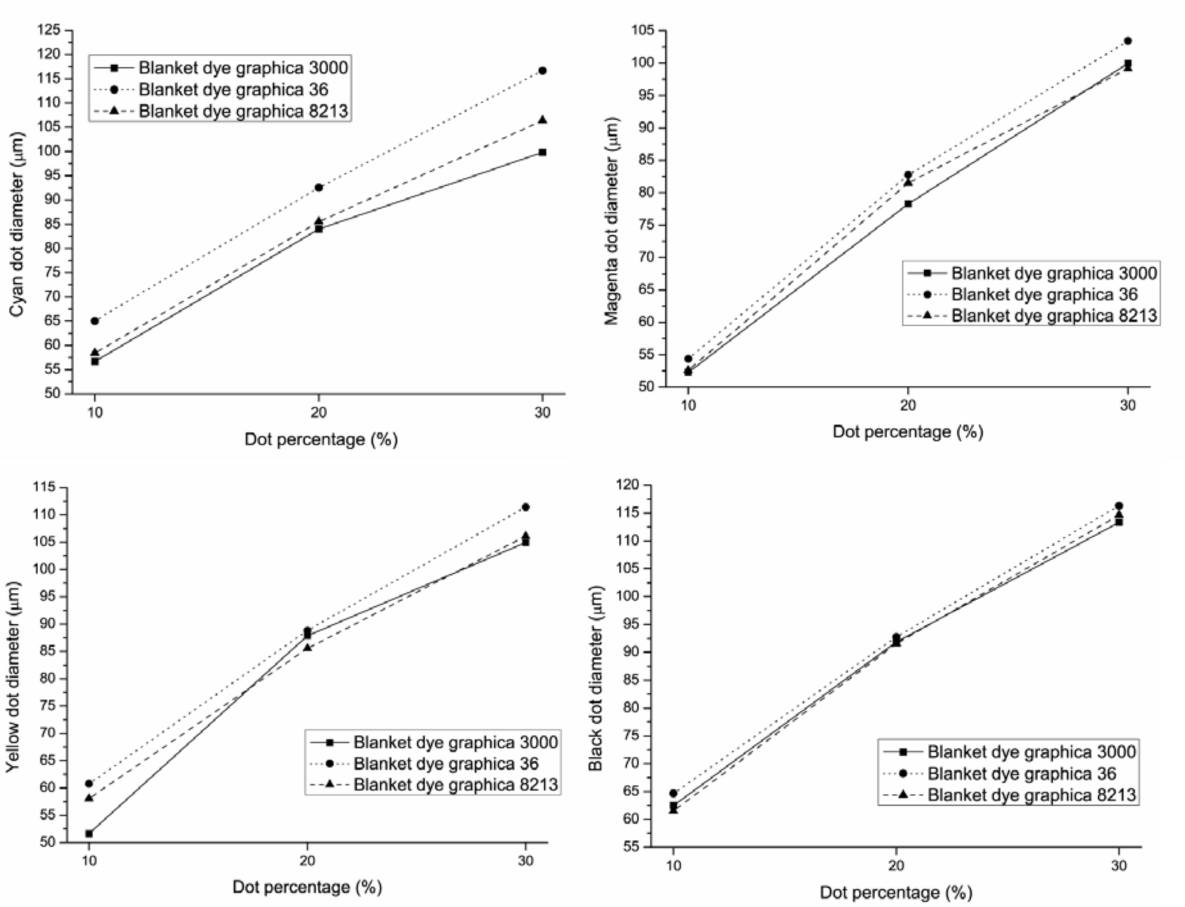

Figure 6: Graphs of dependence of the reproduced changes of the screen elements for the screen area of 10%, 20% and 30%.

For the magenta prints reproduced with the rubber 8213 the greatest oscillation of the screen elements is characteristic. By variation of the rubber offset blankets in the characteristic tested areas (10%, 20% and 30%) the following maximal deviation appears: $\Delta d_{10\%}$=2,12 μm, $\Delta d_{20\%}$=8,56 μm, $\Delta d_{30\%}$=4,3 μm. The screen elements mage by the rubber 8213 coincide with the elements made by the rubber 3000 only in the area of 10% screen value ($\Delta d_{8213-3000}$ = 0,35 μm). In the area of 20% screen value the curve of the rubber 8213 is closer to the curve of the rubber 36, forming the average deviation of the screen elements of $\Delta d_{8213-3000}$ = 3,24 μm. In the area of 30% screen value the curve of the rubber 8213 is again closer to the curve of the rubber 3000 forming the smallest reproduced screen elements ($\Delta d_{3000\text{-}8213}$ = 0,79µm).

The type of the rubber offset blanket influences the reproduction of the yellow screen elements. The greatest deviations of the screen dots diameter are per areas: $\Delta d_{10\%}$=9,08 µm, $\Delta d_{20\%}$=3,33 µm, $\Delta d_{30\%}$=6,5 µm. The rubbers 36 and 8213 show very similar deviations in comparison with the rubber 3000 which has the greatest deviation of the screen elements. In comparison to the non compressible rubber (8213 (the greatest difference is in the area of the smallest screen elements $\Delta d_{8213\text{-}3000}$ = 6,43 µm. In printing with rubber 3000, in the area of 20% screen value, the greater dot gain appears. The screen elements become greater than screen elements printed with the rubber 8213 ($\Delta d_{3000\text{-}8213}$ = 2,34 µm). With greatest printing elements (30% of the screen value) the printing with the rubber 3000 leads to the unexpected fall of the screen elements diameter ($\Delta d_{8213\text{-}3000}$ = 1,16 µm).

By variation of the three types of the rubber offset blankets, the black prints are made which are uniform in all tonal values : $\Delta d_{10\%}$=3,14 µm, $\Delta d_{20\%}$=1,18 µm, $\Delta d_{30\%}$=3 µm. In the area of 10% screen value the smallest screen elements are obtained with the non compressible rubber 8213 which is in comparison to the compressible rubber 3000 less for 0,98 µm. Their printed elements in the area of 20% screen value are equated ($\Delta d_{3000\text{-}8213}$ = 0,27 µm) so that they would become even greater in the greatest screen values obtained by non compressible rubber ($\Delta d_{8213\text{-}3000}$ = 1,28 µm). Such results can be the consequence of the ink arrangements when placing the black ink in the first printing unit and printing of black on absolutely dry paper. All other process colours have greater oscillations because of the wetting solution absorption during which smaller deviation of the printed paper substrate appear (hygroscopic paper changes its dimensional stability).

The geometric deviation of the printed screen elements is presented as the circularity (figure 6) which is defined as the ratio of the length and height of the printed printing element. In ideal case, its value is one (C=1).

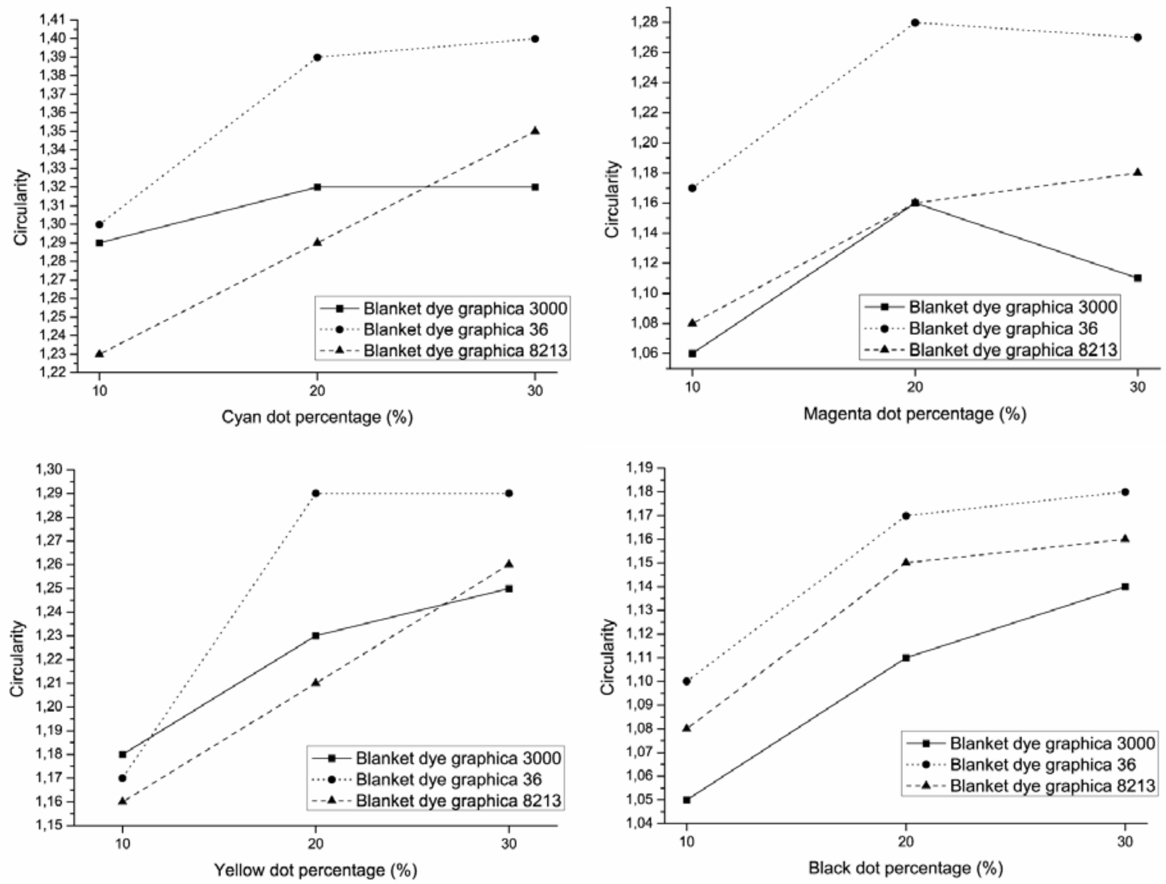

Figure 7 Circularity of the round screen elements in dependence on the ink and screen value

Generally looking, geometrically most irregularly printed screen elements are reproduced with the rubber 36. The smallest printing elements (the area of 10% screen value) keep the greatest roundness. Depending on the rubber type application, the average circularity of the cyan screen dots is C_{3000}=1,31; C_{8213}=1,36; C_{36}=1,29. The cyan dots formed with the non compressible rubber 8213 are characterized by the fact that the increase of the screen values (dot gain) influences the decrease of circularity ($\Delta C_{10\%\text{-}30\%}$=0,12). The compressible rubbers (36 and 3000) will influence the circularity increase only in the areas up to 20% screen value (ΔC_{3000}=0,03; ΔC_{36}=0,09) after which the circularity stabilizes.

Depending on the applied rubber type, the average circularity of the yellow screen dots is C_{3000}=1,22; C_{8213}=1,21; C_{36}=1,25. The yellow prints made with the rubber 8213 follow the constant decrease of circularity $\Delta C_{10\%\text{-}30\%}$=0,10. With the rubber 3000 the circularity grows somewhat slowly ($\Delta C_{10\%\text{-}30\%}$=0,07). The prints obtained with the rubber 36 have great change in circularity in the area between 10 and 20% ($\Delta C_{10\%\text{-}20\%}$=0,12), after which the circularity stabilizes $C_{30\%}$=1,29.

The measured average circularity of the magenta prints is: C_{3000}=1,11; C_{8213}=1,14 C_{36}=1,24. Magenta prints formed with the rubber 3000 are characterized with the circularity fall in the area of 20% screen value ($\Delta C_{10\%\text{-}20\%}$=0,10), so that the tonal values with greater printing elements would have better circularity ($\Delta C_{10\%\text{-}20\%}$=0,05). Variation of the rubber type will directly influence the average circularity of the black screen dots: C_{3000}=1,10; C_{8213}=1,13; C_{36}=1,15. On all black prints with the increase of screen values, the circularity decreases (the rubber 8213 $\Delta C_{10\%\text{-}30\%}$=0,08; rubber 36 $\Delta C_{10\%\text{-}30\%}$=0,07; rubber 3000 $\Delta C_{10\%\text{-}30\%}$=0,08). The rubber 300 with its compressibility will form the smallest reproduced printing elements and it is advisable to use it for the reproduction of frequently modulated screens.

5 Conclusions

On all the experimental impressions the greatest reproduced elements are obtained with the rubber dyegraphica 36, while the smallest ones are obtained with the rubber dyegraphica 3000 (both rubbers are compressible).

By changing the rubber offset blankets it is possible to influence the reproduction directly, i.e. to influence the size of the printed screen elements. By experimental printing with the rubbers dyegraphica 36, dyegraphica 3000 and dyegraphica 8213 the greatest deviations are achieved in cyan screen elements: $\Delta d_{10\%}$=8,43 µm, $\Delta d_{20\%}$=8,56 µm, $\Delta d_{30\%}$=16,86 µm.

The smallest deviations are marked on black impressions: $\Delta d_{10\%}$=3,14 µm, $\Delta d_{20\%}$=1,18 µm, $\Delta d_{30\%}$=3 µm. On the first printing unit (black colour) the non compressible rubber dyegraphica 8213 has lower deformation of the lower tone values as well as greater deformation in greater tone values.

For printing the smallest dots the rubber 3000 is recommended, which gives especially good reproduction of the yellow screen elements. With the rubbers 8213 and 36 the printing elements are not so good reproduced.

On magenta impressions, by changing the compressible rubber (from the type 3000 to the type 36), the greatest change in circularity is obtained (ΔC_M=0,13), while the other colours will have smaller variations (ΔC_M=0,05). Rubber 36 shows identical form of the circularity curves regardless the applied type of ink.

If the non periodic screen (FM screen) is used in the printing process, the usage of compressive rubber 3000 is suggested for black and magenta, and the non compressive rubber 8213 is suggested to be used for cyan and yellow.

6. Literature

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