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**THE INFLUENCE OF THE DEVELOPER DRUM VOLTAGE ON SCREEN DOT FORMATION**

**MAJNARIC, I[gor]; BOLANCA, Z[denka] & BOLANCA MIRKOVIC, I[vana]**

***Abstract:*** *In electro photographic printing with the phase developing, the ink is applied on photoreceptor, and the toner is formed image. In the developing process the voltage influences the toner quality applied on photoreceptor, which primarily influences the future print. The aim of this work is to analyze in details the influence of the developer drum voltage on the process of the black liquid ElectroInk application. Influence on the reproduction of the tinniest printing elements is investigated through the quality of the average screen element by measuring of the optical reflectance. Grayness is examined with the image analysis in the area from 10% to 30% halftone value. The optimal reflectance from the printed dot is achieved with the medium voltage.*

***Key words:*** *electrophotography, developing, voltage variations, screen dot.*

**1. Introduction**

Paper explains influence voltage of developing process on generation individual print dots witch dimension are from 50 to 100 µm. Only exactly printed screen dots would enable accurate color reproduction and prints with petty detail (Gauss fit). In classic printing techniques the reproduction of the screen elements is well investigated. It is the result of the unchanged printing form pressure onto the printing substrate. The defined deviation appears with it.

The technique of electrophotography (EP) is the most complicated printing process (it is performed in 7 phases). The third phase and at the same time the most important one is the developing. During the developing process the negative charged toners adhere to the electrical positive surfaces, generating the toner image. Except the full tone, such image is made of the screen surface composed of a series of the screen dots. Only the defined voltage gives the corresponding screen elements size, which is the basis for achieving all toner values on the print.

The relation analysis between the developer drum voltage and the screen dot is enabled by the image analysis, which gives the reflectance (R%) and the screen dot diameter as the final result. The basis hypothesis is connected with the process of appearing of the tinniest screen element. With this, the achieving of the size, as tiny as possible, and the uniformly grayness of the screen dot is the remarkable factor for increasing the quality of the digital reproduction.

**2. THEORETICAL PART**

eksperiment DAAAM 09 bec2.tifThe liquid and powder (toners) inks are used in electro photography (Yasufumi & Yasuharu, 2002). Electro photography with the liquid toner contains more complicated developing process in relation to EP with the powder toner. The reason for that is the liquid ElectroInk, the base of which is an easy volatile solvent in which the pigment particles and the liquid for electric conductivity increase are dispersed (Schein, 1996).

The developing process is preceded by the charging phase and the laser imaging of photoreceptor, which is the precondition for latent printing form formation. The latent image is the difference of potentials of two extreme voltages the: -700V of the free surface (formed in the charging phase) and -100V printing elements (formed during laser imaging) (Severens, 2004).

In EP developing process with the liquid toner the voluminous developer drum is used, whose surface is permanently charged with the voltage of about -350V. Such voltage corresponds to the half of the total potential difference of the photoreceptor (U=600V). By rotation of the Developer Drum (DD) in opposite direction than the rotation of the photoreceptor drum, the selective application of toner is enabled. The negative charged ink from the free surfaces (-700V) is directed to the positive surface of the DD (-350V), while the ink on printing elements (-100V) remains because of the more positive charge in relation the more negative one of the DD (-350V) (Majnaric et al., 2007).

In order to be able to change the ink layer, the voltage of DD can be changed. It directly influences the change of the full tones inking as well as the structure of the screen elements. With the optical method of the image analysis, it was analyzed how the voltage influences the tinniest printing elements (Fleming et al., 2003).

**3. EXPERIMENTAL**

A special printing form was constructed for investigations. It contained the visual and measuring color stripes for reproduction black and gray tones. The fine art paper (Symbol gloss) with the grammage of 135 g/m2 was used as the printing substrate. Experimental prints were made on 4 color digital EP machine (HP Indigo S-1000). During the printing process the voltage of DD was 5 times changed (-200V, -280V, -350V, -430V, -500V). At the same time the different ink layers were applied. With the device “Personal IAS“, only black prints in light halftone fields (range from 10 to 30% halftone value) were analyzed. In each measured area there were 200 black screen elements, from which the average diameter was calculated. The average diameter was abducted in the correlation with the voltage and optical reflectance (fig. 1).

**4. RESULTS AND DISCUSSION**

The activity of 5 different voltages of DD, on the average size of the black printed screen elements, is presented in fig. 2.

Fig. 1. Schematic presentation of experiments.

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Fig. 2. The influence of the DD voltage on the size of the screen elements for the areas from 10% halftone value, 20% halftone value and 30% halftone value.

Only the results of the black print obtained by the analysis of the printed surface of 2,5 mm2 are presented. About 200 screen elements were processed from which the average value was calculated. There is a valid rule in halftone reproduction which says that the size of the printed screen elements increases with the increase of the halftone value. In all the tone areas the deviation of the screen dots is uniform. In the analyzed area of 10% halftone value the change of the DD voltage (U=300V) generates the following diameters of the screen elements: d-200V=49,41; d-280V=54,69; d-350V=52,54; d-430=56,23 and d-500V=53,01. The greatest screen dot is formed at the voltage of -430V, while the smallest one appears at the voltage of -200VIn the area of 20% halftone value the DD voltage considerably influences the diameters of the printed elements (d200V=72,56µm; d-280V=76,68µm; d-350V=73,42µm; d430=80,66µm and d-500V=80,41µm). The voltage of -200V and -430V realizes the deviation of elements of 8,10 µm. In the area of 30% halftone value the DD voltage change generates the following diameters of the screen elements: d200V=96,52; d280V=98,86; d350V=95,38; d430=102,35 and d500V=102,21. The greatest screen dot is formed at the voltage of -430V, while the smallest one appears at the voltage of -350V. In the area of 20% halftone value, from the printed screen dot, it was analyzed how the DD voltage influences the optical reflectance (fig.3).

The relation of the reflectance and the screen dot size is described by the Gauss distribution curve. The centre of the dot (the darkest part of the print) is described by the low reflectance value, while the paper substrate is described by the high reflectance value. In defining the printing elements the beginning of the dot is at the reflectance of 65%, while the rest is the noise. At the voltage of -200V the dot with the diameter 0,053 mm is formed whose centre of the printed element has the reflectance of (Rcentre= 43,23%).With the DD voltage increase for -150V, the dot with the diameter of 0,081 mm is formed. The lowest reflectance is R=43,07, which causes greater central density for 0,17%. Further voltage increase for -150V forms the dot with the diameter of d=0,064 mm. Although, theoretically such dot should have the highest density, its maximal reflectance is the lowest one R=44,78%. The lowest negative voltage (-200V) enables huge ink removal from the photoreceptor surface and influences directly the removal of the margin zones of the screen elements. It is characteristic that high voltages enable great screen elements, however, the maximal limit for liquid ink is -430V. Extremely high DD voltages leave greater ink quantity on photoreceptor, which influences the closing of screen (dot increase). This is valuable only to the determined limit, after which the voltage increase has an opposite effect.

Gauss tockice2.tif

Fig. 3. The influence of DD voltage on the reflectance of the printed black screen element in the area of 20% halftone value.

**5. Conclusion**

The lowest applied voltage (-200V) creates the tinniest screen dots while the greatest elements are formed with the medium voltage (-430V). The maximal tested voltage (-500V) does not enable the desired increase of the screen elements, so there is no point to apply such high voltages.

The optimal reflectance from the printed dot is achieved with the medium voltage (-350V), which enables the contrast reproduction of the screen elements. The voltage change on DD (U=300V), the printed screen dots will oscillate: in the area of 10% halftone value d=6,82 µm), in the area of 20% halftone valued=8,10 µm) and in the area of 30% halftone valued=6,97 µm). With these cognitions, we can directly influence the preciseness of the reproduction of the halftone values which is the base for achieving the quality print.

Faze of developing (change voltage of DD) can directly influence on final ink layer of the printing substrate. In this paper was analysis only ideal printing substrate (fine art paper which is coated with special varnish) which is ideal for accepting the ink. In the future investigation we would try found optimal voltage for cheaper uncoated and recycled paper, which unfortunately no accepts high quality reproduction.

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