

Printouts' Quality Depending on Too Small Pressure of a Blanket Cylinder Against an Impression Cylinder and a Plate Cylinder in Offset Machine

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It has been written in many books that correct setting of clamp in a printing offset machine has impact on wear of consumables and machine elements, and quality of printouts. However there has been no clear recipe to do that. In our article we present research on effect of too small pressure between a blanket cylinder against a plate cylinder and an impression cylinder. The challenge was to find method for gaining results of printing with different clamp but with the same printing conditions. During printing, especially when the printing machine stops and starts, a balance between ink and dampening solution is changing. To obtain the same printing conditions with different clamp on the blanket cylinder under blanket, there were fixed underlay sheets with the same thickness and width but different length. To reduce influence of variable thickness of glue the underlay sheets was glued to each other only on the one edge. We printed on two kind of papers: coated and uncoated. The amount of ink transported on paper was adjusted by changing rotation of the ink fountain roller. The spectrophotometer was used to measure optical density. The tone value increase was computed with Murray-Davies equation. While the tone value increase and optical density are very important printout parameters, our research shows how change of pressure changes printing quality. Our results also help to understand behavior of ink under pressure. Depending on paper and clamp ink could penetrate into the paper or spreads on the paper surface.

Keywords: contact problem, offset printing, blanket cylinder, rubber blanket

Background

A printing unit in an offset printing machine includes an ink unit, a dampening unit and 3 cylinders: plate, blanket and impression cylinder (a left side of Fig. 1). In the printing technology one may distinguish rollers in the ink and the dampening units and the aforesaid 3 printing cylinders. The rollers are much smaller in diameter than the cylinders and their circumference is closed. While the cylinders are provided with a channel parallel to the cylinders' axis. Inside the channel there are fixtures allowing for clamping a printing plate to the plate cylinder and a blanket to the blanket cylinder as well as there is a gripper system in the impression cylinder which allows for catching the paper.

To ensure adequate contact between rollers and cylinders in a sheet-fed offset machine there is always contact between rubber and metal. This also applies to the printing cylinders. For this purpose the blanket is fixed to the blanket cylinder. Preliminarily, the so called conventional (incompressible) blanket used to be made of a rubber top layer and fabrics. However, as a consequence of the pressure between the cylinders the rubber bulged on the two sides of the contact area which resulted in a difference in circumferential speed of the blanket and the plate, thus bringing about deformation of the printing dots (Dejidas and Destree, 2005). Therefore, a compressible layer was put between fabrics. The layer is made of synthetic rubber

resembling a sponge – it has closed or, as the case may be, opened microchannels or micropores. When the cylinders get in contact, first the compressible layer squeezes and as soon as its full squeeze is achieved it entails the rubber top layer squeeze. In the event only the compressible layer squeezes nearly no rubber top layer bulges take place. Also the compressible layer does not bulges, thanks to the micropores. We can also say that the compressible layer discloses the Poisson's ratio close to zero, because when the layer becomes less thick, its width deformations become negligible.

Numerous books say how it is important to correctly set the pressure (Dejidas, Desree, 2005 & Destree, 2005 & Kipphan, 2001 & Panak et al., 2002). According to these books, the pressure is meaningful for the quality of printouts and the wear of consumables and machine's elements. This research aims at analysing the tone value increase and the optical density as quality parameters which depend on pressure.

We have found no articles which would describe any results of research of the printouts' quality (optical density and tone value increase) depending on pressure. In the article (Singh, Johansson and Bristow, 1996) specifies a method of changing pressure, so it is impossible to assess if the applied method was correct, namely if it met the prerequisite requiring identical printing conditions for different pressure. In the article (Megat Ahmedy, Gethinz,

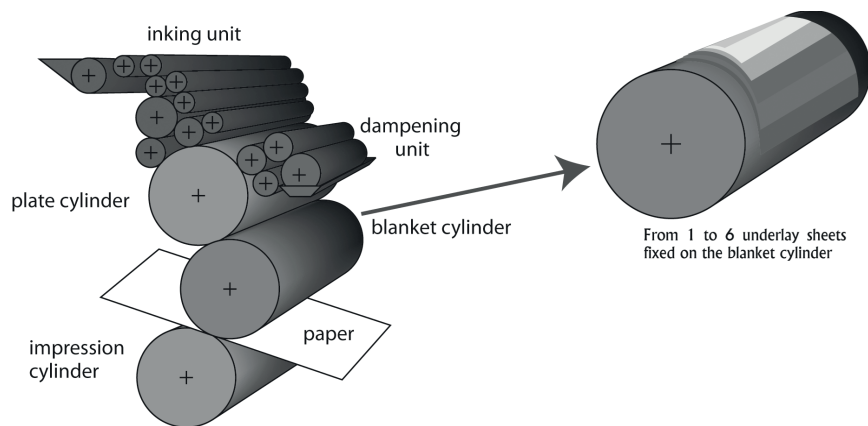


Fig. 1. Printing unit and the place where underlay sheets are fixed

Claypolez and Roylancez, 1997) there was research about the influence of pressure on dot gain – the tone value increase. But there is not described two important things. First is if they used incompressible or compressible blanket. Second how they obtain different values of pressure (if they have the same printing conditions during printing with different pressure). They did not write on what sorts of paper they printed, but they written about porous substrate, so we can assume that they printed of uncoated paper. In the article (Koivula, Preston, Heard and Toivakka, 2008) is written about behavior of the ink components, which are visible using microscope with focused ion beam (FIB). This ink was printed on the coated paper. The empirical equation for transfer of ink between rollers is available in (Walker and Fetsko, 1955).

Materials and methods

A very difficult issue to solve, whenever examining the influence of pressure on printouts' quality, regards obtaining results of printing with different pressure under the same printing conditions. When the blanket cylinder moves closer to the plate cylinder or to the impression cylinder, or when the impression cylinder moves closer to the blanket cylinder, the machine must be stopped. When the machine is re-started the printing conditions differ from those before stopping the machine, especially as regards the balance between ink and the dampening solution. So, printouts before stopping the machine and after its re-start cannot be referred to as comparable. During our research this problem was successfully solved. There were used different quantities of underlay sheets fixed under the blanket on the blanket cylinder (Fig. 1). For purposes of this research 6 underlay sheets were taken into account. In order to preclude the variable glue thickness factors the underlay sheets were glued to each other at one edge only, and not on their entire surface. This allowed for generating the biggest pressure where 6 underlay sheets were used, and the smallest pressure – where 1 underlay sheet was used (in the latter case there were no other five underlay sheets because they were shorter than the remaining 1 underlay sheet).

For purposes of this research a test has been designed in the A3 format (Fig. 2). The test consists of 6 identical rows, and each of them includes the same segment (element (a), Fig. 2) from the operator's side and from the drive's side. This segment includes two scales from 10% to 100% stepping regularly by 10% oriented in opposite directions (element (2) on the Fig. 3), the tone field values running from 1% to 5% and the fields with tone values from 95% to 99% stepping regularly by 1% (element (3), Fig. 3), as well as vertical and horizontal and positive and negative microlines (element (4), Fig. 3), as well as fields allowing for doubling control (element (5), Fig. 3). Next to the tone value scale stepping regularly by 10% there are additional fields with tone values of 25% and 75%.

Furthermore, in the middle of printouts there is another scale stepping by 10% and a caption informing the test designer (element (b), Fig. 3). Throughout the printout width there is a control stripe with full-tone fields (element (1), Fig. 3).

The gray background between the test elements has a tone value totaling 50% of black colour. It more or less corresponds to the average tone value on the test, looking along the printing. It was placed on the test to prevent from accumulating too much ink on the cylinders which is not transferred farther. Otherwise, unexpected errors might arise disturbing the research results. Between particular rows a 2 cm space was left (element (c) on the Fig. 2) which was covered by 50% of black colour. It was because this place is a boundary between different pressures (in the middle part of that space was a beginning of a new underlay sheet). Additionally, both sides of the test were provided with a 7 cm wide space (element (d), Fig. 3). Preliminarily, the width of the underlay sheets was smaller than width of the designed test. The so obtained free space aims at checking if there are any unforeseen phenomena across the printing which may affect the research results. During the examination it was necessary to adjust the width of the underlay sheets so that it was equal to the width of the test.

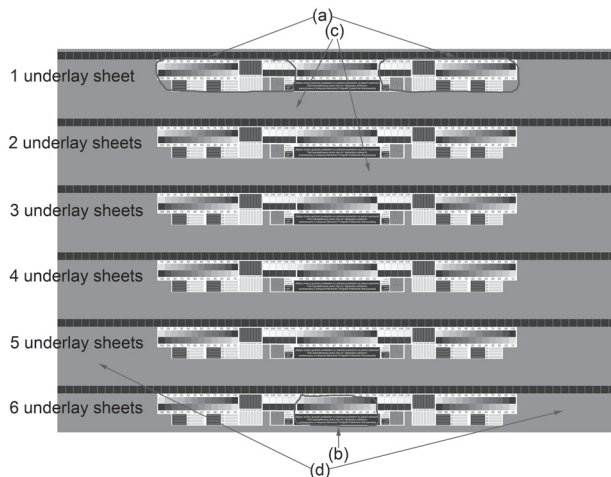


Fig. 2. Test for research the change of printouts' quality depending on pressure of a blanket cylinder against an impression cylinder and a plate cylinder

The plate was made using the CtP (Computer to Plate) method. It was exposed to light with a screen ruling 150 lpi and resolution 2400 dpi.

The designed test was printed using a sheet-fed offset printing machine Adast Dominant 515 in standardized conditions. The cyan ink was used. The printouts were made with the ink amount being changed due to reducing the ink fountain roller rotation (this roller periodically conveys the ink from the ink fountain onto other rollers of the ink unit). The printing speed was 3000 printouts per hour. BT 3200 blanket by Böttcher was used which is made of 4 fabrics and a compressible layer with closed micropores. It was printed on a double coated paper with grammage of 115 g/m² and on an uncoated paper with grammage of 120 g/m².

Spectrophotometer Gretag SpectroEye was used to measure optical density using the tone value scale showing fields from 10% to 100% with a single step by 10%. The optical density for non-transparent materials is a common logarithm of ratio between the amount of light falling on the sample and the amount of light reflected (Sharma and Pietrzak, 2006). Measurements were taken for 3 fields 40%, 50% and 60%, because for these fields the tone value increase is biggest so it is the easiest to find any relationship. Additionally, the optical density was measured for field 100%, because this parameter is required to compute the tone value $S[\%]$ on the printout. This parameter $S[\%]$ is computed with the Murray-Davies equation (Standard ISO 12647-1, 2004):

$$S = 100 \cdot \left(\frac{1 - 10^{-(D_t - D_0)}}{1 - 10^{-(D_s - D_0)}} \right) \quad (1)$$

where

- optical density of the unprinted print substrate (paper),
- optical density of the half-tone,
- optical density of the solid.

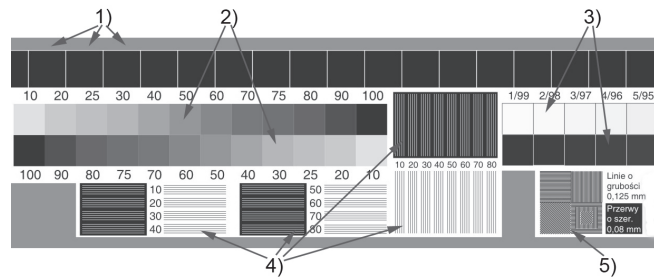


Fig. 3. Part of the test: (1) solid fields with 100% of the tone value, (2) the tone value scales from 10% to 100% stepping regularly by 10%, (3) the tone value scales from 1% to 5% and from 95% to 99% stepping regularly by 1%, (4) vertical and horizontal positive and negative micro-lines, (5) fields for controlling doubling

Whereas the tone value increase is a difference between the tone value on the printout copy and on the original (Standard ISO 12647-1, 2004). In other words, it corresponds to an increase in the surface of printed dots compared to dots on the original.

For each field 3 measurements were taken to reduce a risk of measurement errors. The spectrophotometer was set as follows: Illuminant A, Observer 2°, density standard DIN, polarizing filter and as a standard whiteness – paper. The measurements were taken in 3 parts of the printout: from the drive's side, in the middle part and from the operator's side.

Out of several hundred printouts over a dozen printouts for each kind of papers were selected. The criterion of the selection was optical density of the middle full-tone field of the control stripe including full-tone fields placed in the row for 5 underlay sheets. The printouts were selected whose optical density of middle full-tone field changed by about 0.1. With respect to the optical density showing a value close to the correct optical density the selection concentration was set to 0.01. For the coated paper the correct optical density is 1.55 (according to recommendations by Heidelberg). Therefore, 11 printouts were selected from within the range 1.50–1.60. As regards the uncoated paper its correct optical density is 1.05 (according to recommendations by Heidelberg). Therefore, 11 printouts were selected from within the range 1.00–1.10.

Results

We made printouts on two sorts of paper: uncoated and coated. The optical density and the tone value increase were measured. In this paper, there are presented results for the field 50% (here half of the field's surface should be covered with printing) and for field 100% (here the entire field's surface should be covered with printing). The other curves

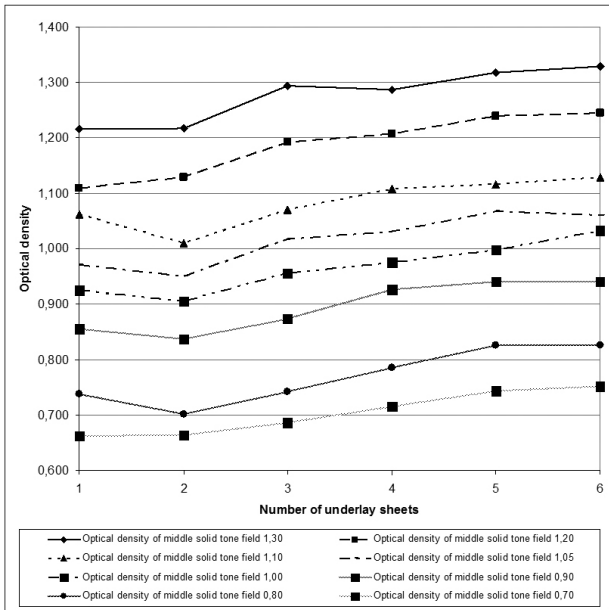


Fig. 4. The optical density for field with tone value 100% for changing amount of ink for uncoated paper

on the graphs represent different amounts of ink used on the printouts. The curves corresponding to a printout with optical density of middle field equaling 1.05 for the uncoated paper and 1.55 for the coated paper are curves representing printouts with correct amount of ink. The horizontal axis shows quantities of underlay sheets – the less underlay sheets are used, the less is the clamp value. For 5 underlay sheets the correct clamp value is set, and for 6 – the clamp value setting is too big.

Uncoated paper

As regards the optical density curves for the field 100% (Fig. 4) a slightly downward trend with a decrease in the clamp value is seen. The decrease is greater when more ink is used on the printouts. The maximum difference between the optical density for the correct (for 5 underlay sheets) and the minimum (1 underlay sheet) clamp value is about 0.11.

As regards optical density curves for the field 50% (Fig. 5), like for the field 100%, a slight decrease in optical density followed with a decreasing clamp value has been noted. The difference between the optical density of the correct and the minimum clamp value for the field 50% is even lower than in the case of the field 100%. It is from 0,02 to 0,07. The less amount of ink on the printout, the smaller is the difference. In the field of the tonal values 100% the printed dots should cover the entire surface of the field, and in the field 50% – half of the surface. Because the difference in the optical density between the correct and the minimum clamp value is larger for the field 100%, the surface of dots does not change most likely, but the thickness of the ink layer and the depth at which the ink penetrates the paper decreases with decreasing the clamp value. The

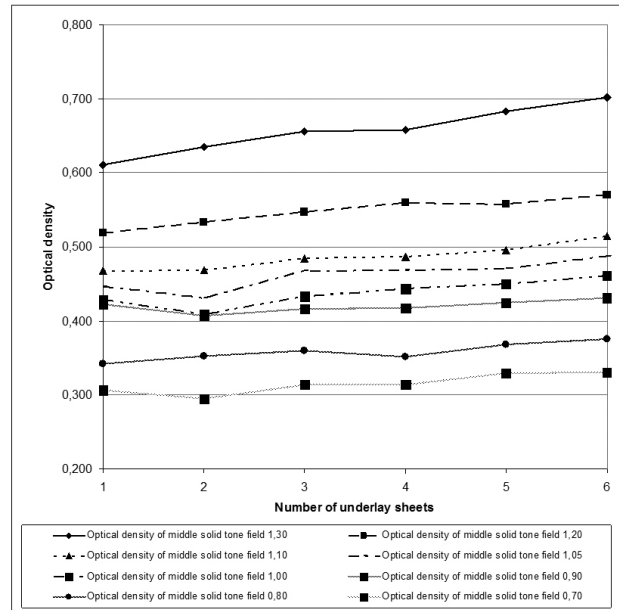


Fig. 5. The optical density for field with tone value 50% for changing amount of ink for uncoated paper

optical density for uncoated paper changes with change of clamp value because of problem with smoothing irregularities of paper surface. The less clamp between cylinders, the paper is more uneven during transferring the ink from the blanket cylinder. In that moment the ink does not penetrate the irregularities.

The tone value increase curves for the field 50% (Fig. 6) confirm the conclusion derived from the previous two graphs that decreasing the clamp value entails a decrease of the ink layer thickness and the depth of penetration of the ink into the paper rather than a decrease of the dots surface.

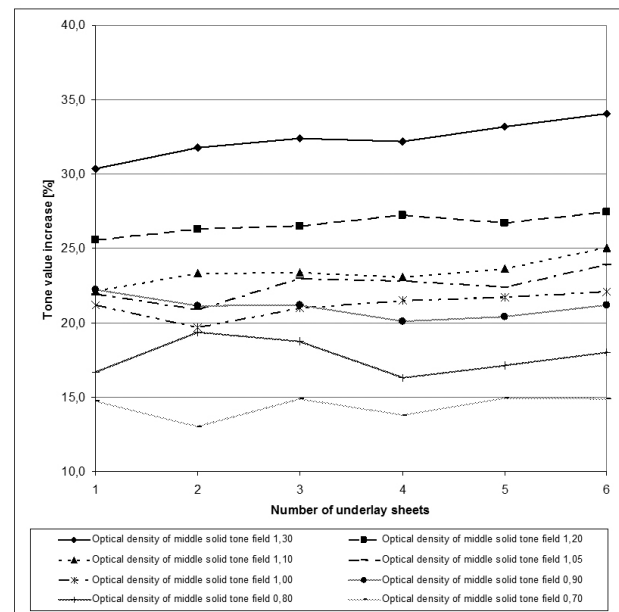


Fig. 6. The tone value increase for field with tone value 50% for changing amount of ink for uncoated paper

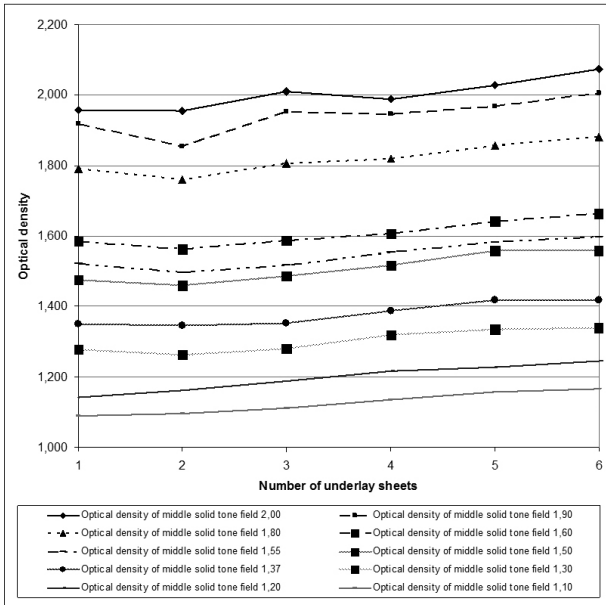


Fig. 7. The optical density for field with tone value 100% for changing amount of ink for coated paper

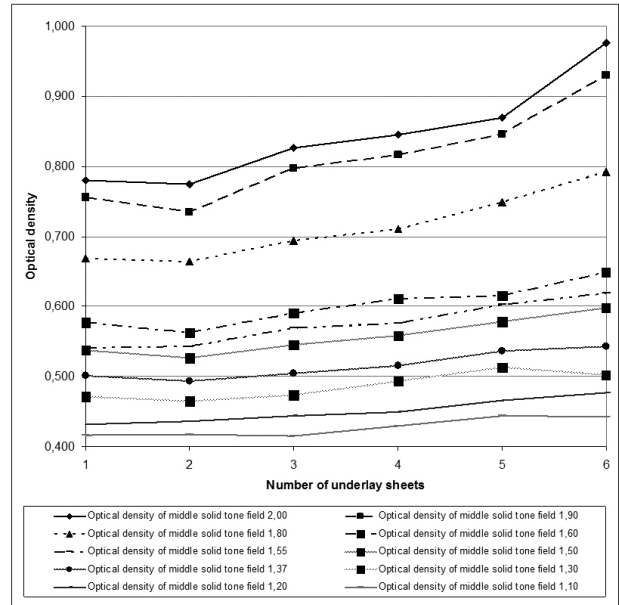


Fig. 8. The optical density for field with tone value 50% for changing amount of ink for coated paper

The graph shows that, except for the curve for the largest amount of ink, the difference between the correct and the minimum clamp value runs within 0–1.5%. This proves a very slight upward trend, and because of the fluctuations in the curves, it can be assumed that the surface of dots hardly changes with decreasing the clamp value.

Coated paper

With respect to the coated paper, like for the uncoated paper, decreasing the clamp value brings about decrease of the optical density and of the tone value increase. As regards the field 100% (Fig. 7) a difference of the optical density between the correct and the minimum clamp is less than for the uncoated paper. For all curves, except printout with the less amount of ink, this difference is from 0,04 to 0,09.

For field 50% (Fig. 8) the difference of the optical density between the correct and the minimum clamp is similar to field 100%, and the range is from 0.04 to 0.09. It is a little more than in the case of the optical density on the field 50% on the uncoated paper. A similar difference for the fields 100% and 50% means that the thickness of ink layer changes. On the coated paper, the ink hardly penetrates into the paper.

The difference in the tone value increase between the correct and the minimum clamp for the field 50% (Fig. 9) is larger than for the uncoated paper. The difference is about 2–4%. For too small amount of ink is less. Yet, it means that the clamp hardly affects the tone value increase. This graph shows some deformations of printing dots following the change in clamp set below the optimal clamp. In the case of coated paper we have not such problem with irregularities of paper surface and smoothing them like with uncoated paper. All surface of print dot is covered by ink.

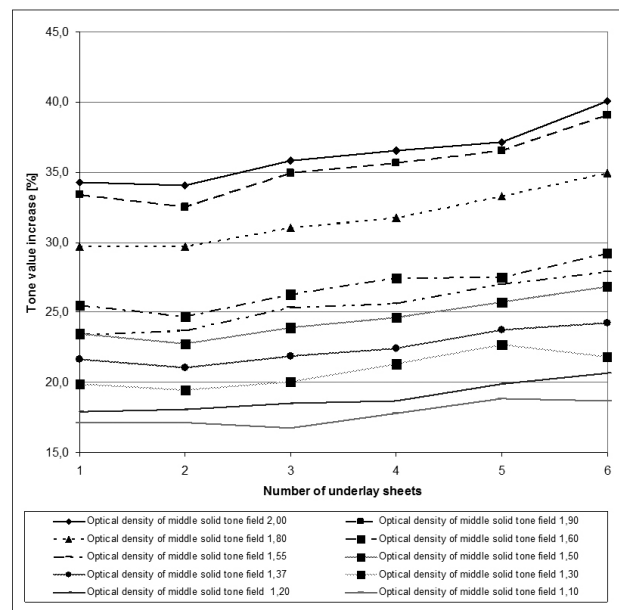


Fig. 9 The tone value increase for field with tone value 50% for changing amount of ink for coated paper

So the difference between the minimum and the correct value of the tone value increase is bigger. In this case the clamp is bigger, the squeezing ink out of the point. When during the printing is used less ink, less ink is squeezed out of the printing point.

Conclusion

For the two types of paper, the tone value increase and the optical density slightly change depending on the quantity of the underlay sheets, i.e. on the variable clamp set below the optimal clamp value recommended by the manufac-

turer. In case of the coated paper, for the field 50% the changes are slightly bigger than for the uncoated paper. For the two types of paper a downward trend is observed for the optical density and for the tone value decrease along with decreasing the clamp.

Probably with respect to the small clamp value only the compression layer in compressible blanket squeezes, so printing dots should not deform. It means that the tone value increase should not change. However, the optical density may slightly change, because if the clamp is smaller, the contact zone between the cylinders is smaller, and thus less ink is transferred. In practice, the rubber layer squeezes very little, so there are very small changes in the tone value increase. The changes are very little, so we can assume that during printing with a smaller clamp value than recommended by the manufacturer only the compressible layer squeezes.

With respect to the uncoated paper, we may conclude from the graph of optical density for the field 50% and 100% and from the graph of the tone value increase for the field 50% that a too little clamp brings about a change in the ink thickness and the depth of ink penetration into paper. It is important, that when the clamp is too small, the irregularities of paper surface are not smoothing properly. So there are difficulties with transferring ink on all printing point. In the case of the coated paper, such a change is observed both in size of the printing dots surface and in the ink thickness.

For the future research purposes we plan to confirm the aforesaid assumptions. Therefore, we are going to look at and measure printouts, using the optical and scanning microscope.

It is noteworthy to consider a method of printing with different clamp values. This method allows for printing at variable clamp values and using identical printing conditions.

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