2nd International Joint Conference on Environmental and Light Industry Technologies,

21 – 22 November 2011, Budapest, Hungary

Óbuda University

INFLUENCE OF INK VOLUME ON K/S VALUES AND SURFACE REFLECTANCE OF PRINTED TEXTILE MATERIAL

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Abstract:

Characteristics of textile materials can determine their behaviour in process of exploitation. In the exploitation process characteristics of the material are changing. Printing process is also influence factor, because it changes some of the materials characteristics. This paper presents investigation in to influence of digital printing on K/S values of material (K - Absorption Coefficient of the material, S - Scattering Coefficient of the material) and changes in the reflectance of the materials. The volume of ink transferred on the material was varied; five different ink volumes were applied to material and used in analysis. The fields of 100% coverage for all process colours (CMYK) were printed. The hypothesis of this experiment was that with increasing ink volumes K/S values will be higher and it also causes reduction in surface reflectivity.

Keywords:

ink volumes, K/S values, spectral curves, surface reflectance

1 INTRODUCTION

Characteristics of textile materials can determine their behaviour in process of exploitation. In the exploitation process materials always lose some basic characteristics [1]. Printing process is also influence factor, because it changes some of the materials characteristics. This paper presents investigation in to influence of different volumes of ink printed with digital printing on K/S values of material (K - Absorption Coefficient of the material, S - Scattering Coefficient of the material) and changes in the reflectance of the materials.

The colour strength (K/S value) of dyed or printed fabrics is a measure of dye or pigment concentration on the fabric. It is calculated by measuring the K/S values of the dyed or printed fabrics with a spectrophotometer under a reflectance mode. The principle is based on Kubelka-Munk theory which gives the relationship between the K/S and R (reflectance) [2, 3]. The colour strength of the printed samples was calculated using the Kubelka-Munk equation:

$$K/S = (1 - R)^2/2R \qquad (1)$$

Where R – is reflectance of an incident light from the material, K – is absorption coefficient of the material, and S – is scattering coefficient of the material. All the K/S values in this study were determined at the maximum absorption wavelength (λmax) at which the reflectance value is the lowest.

Spectral reflectance curve is a graph of the spectral reflectance of an object as a function of wavelength [4, 5]. Configuration of the spectral reflectance curves gives us insights into the spectral characteristics of an object. Spectral reflectance curves guide us in selecting wavelengths region(s) in which remote sensing data should be acquired for the given science goal.

The hypothesis of this experiment was that with increasing ink volumes K/S values will be higher and it also causes reduction in surface reflectivity.

2 EXPERIMENTAL

In the experiment the material composed of 100% polyester (determined using standard SRPS F.S3.112) was examined. It could be characterized by following parameters: fabric weight (g/m^2) – 120,6 (determined using standard SRPS F.S2.016) and thread count (p/10 cm) – warp: 200, weft: 140 (determined using standard SRPS F.S2.013). Generally, polyester textile materials are well known for their strong fastness and durability [6] and those material was printed by digital inkjet printing machine Mimaki JV22-160. J-eco Subly nano inks produced based on nanodot technology were used. The volume of ink transferred on the material was varied; five different ink volumes were applied to material and used in analysis. The fields of 100% coverage for all process colours (CMYK) were printed.

For all samples we determined the colour strength (K/S value) and spectral curves. Colour strength was determined with a spherical Datacolor Sectraflash SF 600® PLUS – CT spectrophotometer. We used d/8 measurement geometry with 16 mm aperture, with D_{65} standard illuminant and 10^0 standard observer.

Spectral curves was determined with Spectro Dens with directional $0^0/45^0$ measurement geometry, D_{50} standard illuminant and 2^0 standard observer.

3 RESULTS

In those experiment, we determined the colour strength (K/S values) using the Kubelka Munk analysis. The K/S values for cyan with different volumes of inks is presented in Figure 1. We can see that with every additional printing layer the K/S value is rising. There is a liner correlation between number of ink layers and K/S values, with high degrees of determination factor R^2 = 0,991.

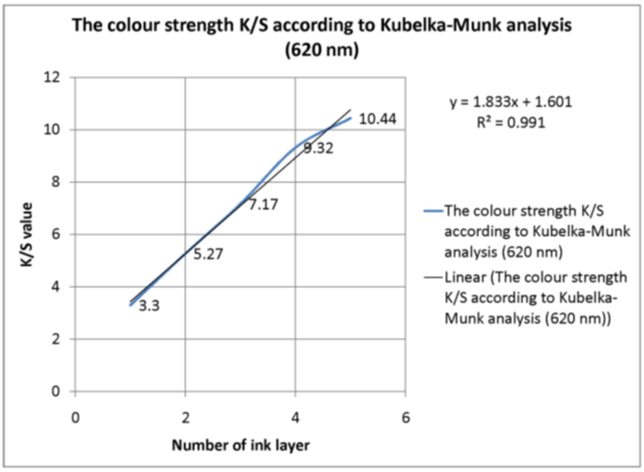

Figure 1: Colour strength according to Kubelka – Munk analysis – cyan in relation to number of ink layers

Similar to samples printed with different volumes of cyan ink, we also find linear correlation between number of ink layers and K/S values, when we tested samples printed with magenta, yellow and black. The largest R^2 was determined for the black colour and was 0,997 (figure 4). R^2 was 0,979 when we analyzed magenta (figure 2) and 0,996 when we analyzed yellow (figure 3).

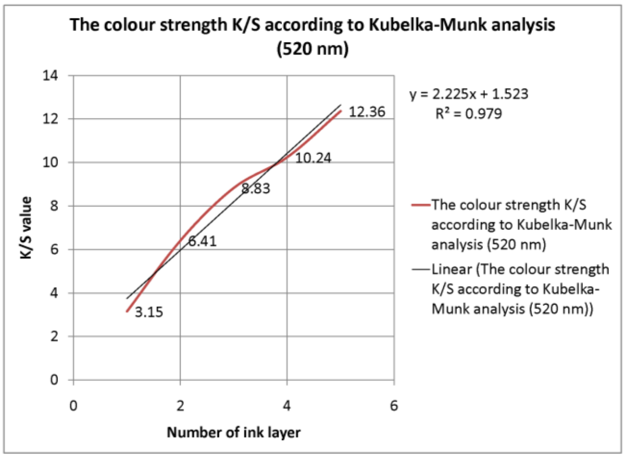

Figure 2: Colour strength according to Kubelka – Munk analysis – magenta in relation to number of ink layer

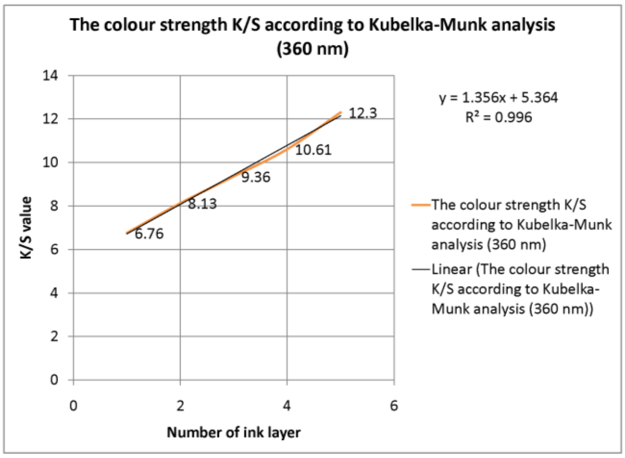

Figure 3: Colour strength according to Kubelka – Munk analysis – yellow in relation to number of ink layer

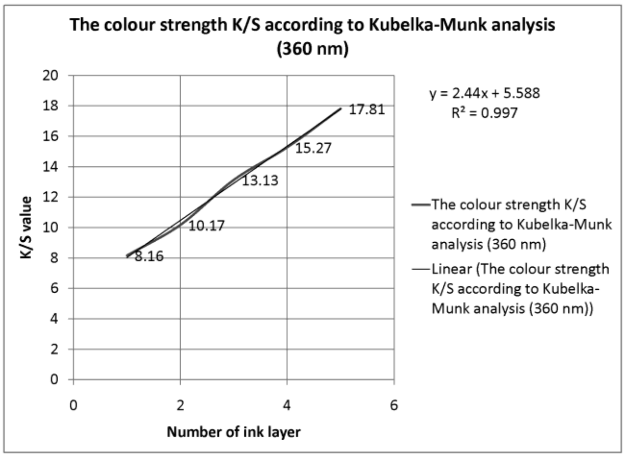

Figure 4: Colour strength according to Kubelka – Munk analaysis – black in relation to number of ink layers

When K/S values for all samples were determine with the reflection spectrophotometer Spectro Dens, we determined spectral curves for different volumes of ink. From Figures 5a, 5b, 5c and 5d we can observe that with increasing number of ink layers its reflectance is decreasing. It is important to notice that all the samples of this material showed a similar trend, where the application of additional ink caused smaller reflectance.

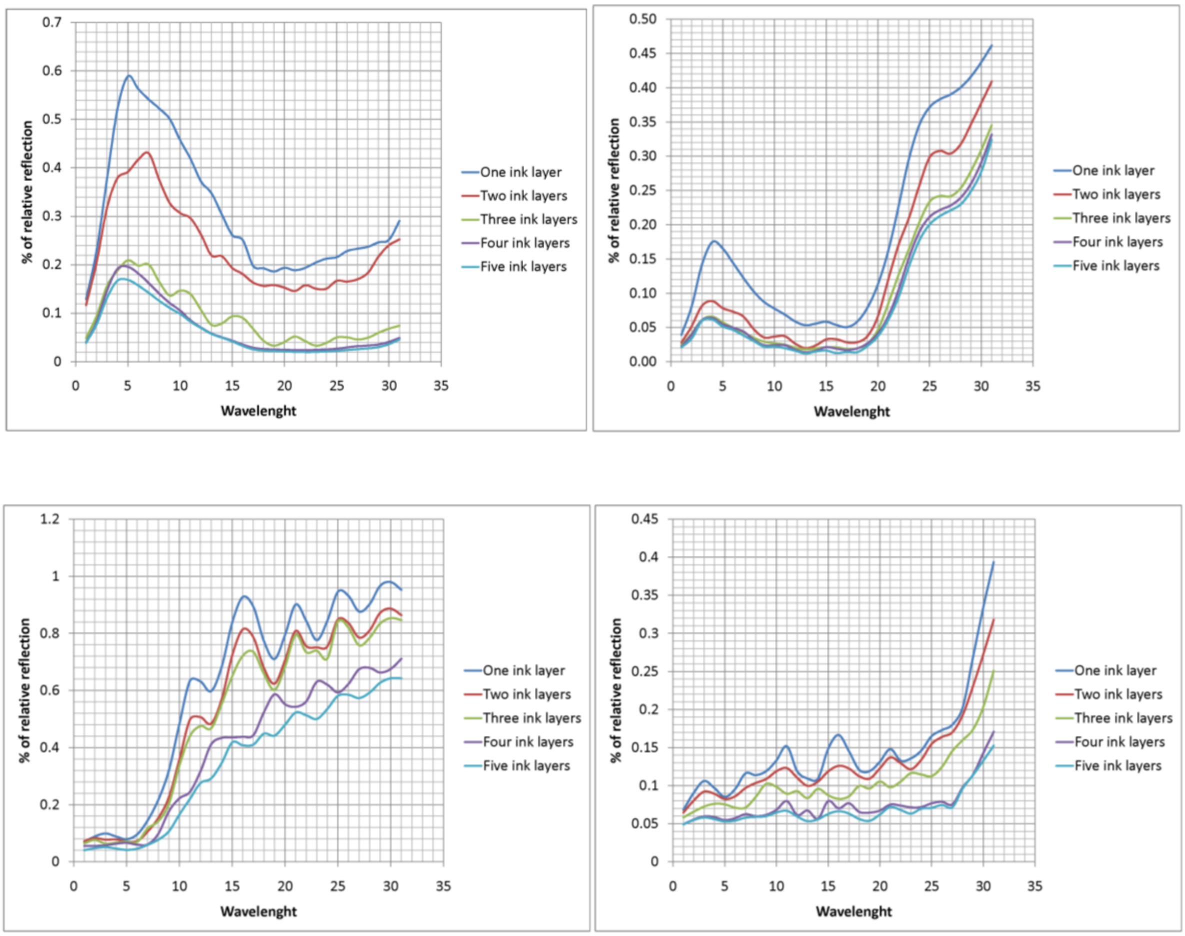

Figure 5: Spectral curves for ink layers of a) cyan, b) magenta, c) yellow, d) black

4 DISCUSSION

Based on the results we can see that the increasing the number of ink layers will increase K / S values. For all process colours, increasing the number of ink layers will linearly increase values for K / S which was confirmed with high coefficients of determination. Based on this information we can conclude that we found the correlation between the number of ink layers and K/S values. The highest values of K / S were noticed black ink prints. K / S values of prints with different number of ink layers for magenta and yellow inks were smaller but similar to each other. Samples printed with cyan ink had the smallest K/S values. Increasing the number of ink layers were reduces a percentage of relative reflectance, which is shown with the spectral curves (figure 5). This is consequence of increasing K / S values, because the larger amount of ink absorbs more light.

5 CONCLUSION

The aim of this study was to prove that that K/S values will be higher with increasing ink volumes and it also causes reduction in surface reflectivity. In this case only one material with specific characteristic was examined. Samples were split in to four group (process colours). The results confirmed the hypothesis that increasing the number of ink layers could increase K / S values and reduce percentage of relative reflectance. Based on this analysis, we can concluded that similar results would be obtained if we were to change some factors, such as material, types of inks and type of printing machines.

ACKNOWLEDGEMENTS

This work was supported by the Serbian Ministry of Science and Technological Development, Grant No.:35027 "The development of software model for improvement of knowledge and production in graphic arts industry"

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