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Colorimetric changes of waterbased flexographic ink printed on hemp-based papers exposed to artificial ageing

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Introduction

During past years, the worldwide capacity for production of non-wood plant fiber pulps has increased dramatically. These plants with widely differing characteristics, such as bagasse, wheat and rice straws, bamboo, hemp and kenaf are being used as a raw material in the manufacture of pulp and paper all over the world. Many of them are used still only on experimentally bases, while some of them are used in commercial paper mills. However, still the highest percentage up to 92 % of world paper production is based on wood plant fibers . From the moment of production, the paper is subject to the natural ageing process which can be defined as a sum of all irreversible chemical and physical processes which occurs in organic materials slowly during time. It can be characterized as materials with high sensitivity to temperature and light that are the most common degradation factors. The ink will also experience a change due to exposure to external factors as light, heat, humidity and air quality and all these natural processes of deterioration start as soon as ink is printed. So unquestionably the analysis of the colorimetric changes of prints must be perceived by two factors: the ageing of paper and ink.

Problem Description

As the flexography is the fastest growing global analog print method which can be performed on a wide range of materials and substrates (absorbent and nonabsorbent) and with substantially improvement in quality due years , it is evident why the prints made by this printing technique are the subject of our research. In this study, experiment was carried out in condition of artificial aging where the ageing phenomenon of flexographic prints was analyzed through spectrophotometric changes of prints obtained on papers containing hemp fibers.

Methods

Printing substrates

In this research three types of hemp-based office papers with approximately the same nominal grammage (90 g/m^2) were used as printing substrates (Table 1).

Table1

Description of papers used as printing substrates

Hemp-based office papers		
Type 1	Type 2	Type 3
unbleached, uncoated handmade sustainable paper made from 100% hemp plant fiber	non-chlorine bleached, uncoated handmade sustainable paper made from 100% hemp plant fiber	natural, unbleached white industrial paper made from 25% hemp and 75% post-consumer waste fibers

Full tone flexographic prints

Hemp-based office papers were cut in dimensions 190 mm x 40 mm and subjected to manual printing using a print tester Esiproof (RK print). The prints in cyan, magenta, yellow and black was made in full tone by Iroflex 917, waterbased flexographic inks manufactured by Sun Chemical. Prints were obtained using a ceramic anilox roller with 40 lin/cm, 60° spread angle and a cell volume of 39.10 cm^3/m^2. The printing process was carried out at a temperature of 23 °C and a relative humidity of 50%.

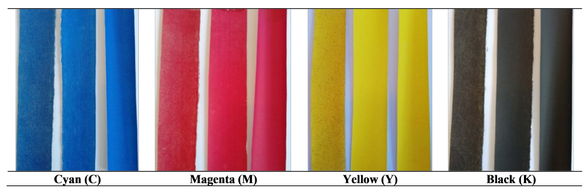

Figure 1

Prints

Artificial ageing

Papers and prints were cut into strips 60 mm x 90 mm and placed side by side in Suntest XLS+ test chamber, supplied with a daylight filter, which emit the UV radiation of wavelength in range of 290 nm – 800 nm. The procedure of artificial ageing was carried out according to ASTM D 6789-02, during which the level of light intensity was 765 ± 50 W/m^2, the temperature was kept at 22.6°C and relative humidity was 50%. Exposure to the UV radiation was performed in two cycles for 48 hours. Approximately one hour of treatment under a xenon lamp corresponding to one day in nature.The colorimetric values of papers as printing substrates and prints were determined using a spectrophotometer X-Rite SpectroEye. Color data were measured under illuminant D65, 2° standard observers. On the basis of thse measurements, the colorimetric difference (ΔE_{00}*), which appeared after ageing, were calculated with the following equation, using the corresponding unaged paper or print as reference:

$$\Delta E_{00}^{*} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \frac{\Delta C'}{k_C S_C}\frac{\Delta H'}{k_H S_H}}$$

Results

Colorimetric changes of hemp-based office paper as printing substrate

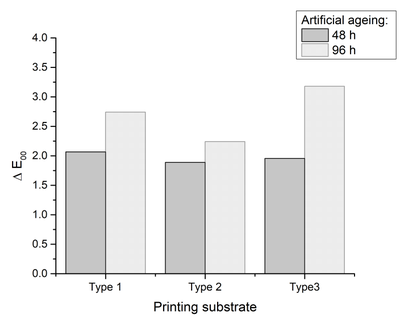

Figure 2

Color difference of tree types of paper used as printing substrate during artificial ageing

Colorimetric changes of prints

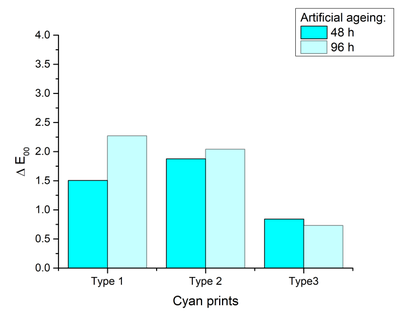

Figure 3

Color difference of prints on papers during artificial ageing

Conclusion

The aim of this study was to investigate colorimetric changes of printed office hemp-based papers subjected to artificial ageing. The results have shown that the lowest impact of UV radiation treatment was on paper made only from bleached hemp fibers. However, this office paper as printing substrate has not provided the best stability of prints under UV radiation treatment for all flexographic inks. From all results it could be concluded how color stability of prints are mainly defined by the type of pigment and ink, but also by the ink interaction with the printing substrate. Once again it was proven how the most stable are prints with the black ink, while prints with the yellow ink under the influence of light had the greatest changes in color.

ACKNOWLEDGMENTS

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