Colorimetric Properties of the Prints During Ageing

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Abstract

On the mechanical strength, chemical stability and optical characteristics of paper, i.e. prints during aging can influence the interaction of paper components, conditions of its production, microclimatic conditions, air pollution by some pollutants, printing techniques, chemistry and characteristics of inks and finishing conditions.

In this work some characteristics of the four-color printing, performed in conventional offset printing technique and two different digital printing techniques on different printing substrates during ageing have been studied.

The colorimetric characteristic of the offset and the two kinds of digital prints and its quality in contest of various kinds of inks, printing substrates, printing techniques and prints durability during ageing are discused in this paper.

Introduction

During aging of prints, interactions among printing substrate components are possible and the activities of some parameters from the surroundings are recognizable. Generally, in regard to the changes of paper and prints during aging, the terms durability and permanence are very interesting.[1] Durability of paper depends on mechanical and physical properties of raw materials used in paper production, such as fibers, fillers, sizing agents and additives.[2] Concerning the durability the influence of the environment elements such as air pollution by sulfur and nitrogen oxides, ozone or biological agents, microorganisms and mold are recognizable. Except that microclimatic conditions, primarily heat, humidity and light can be active. Print permanence depends on chemical resistance of the components on external factors.[3] It includes lightfastness and points at resistivity of the printing ink against fading and color change after exposition to light or weather.[4]

All the mentioned facts, beginning from the interaction of paper components, conditions of its production, microclimatic conditions, air pollution by some pollutants up to printing techniques, chemistry and characteristics of inks and finishing conditions can influence the mechanical strength, chemical stability and optical characteristics of paper, i.e. prints during aging.[5,6]

In this work some characteristics of the four-color printing, performed in conventional offset printing technique and two different digital printing techniques on different printing substrates have been studied.

For printing in conventional offset printing technique model inks were used with different ratios of renewable raw materials. These researches are interesting in technological point of view, (influence on some rheological ink properties, ink transfer from the rubber dressing to the printing surface, the range of ink-water balance, the speed of prints delivery, etc.) in regard to the print quality and from the ecological aspect (resource savings, deinkability, biological decomposition of inks).[7,8,9]

The measuring results of some parameters influencing the print quality, as well as the optical and colorimetric characteristics of paper and prints during aging are discussed in the article.

Experimental

The printing machines MAN Roland 300, Indigo E print and Xerox have been used for printing. The test form contained wedges of tonal values from 0 - 100% coverage in steps of 10% and two screen kinds (amplitude modulated - 60 l/cm, 80 l/cm and frequently modulated - fine and coarse). The same test printing form presented in figure 1 was used in all the printings.

Figure 1.Test printing form

Additional conditions in printing were following: the solid area must be completely covered by ink, the screen patch with 90% screen value must not be closed and the field with 10% screen value must be correctly printed.

Model offset inks with the composition presented in table 1, electro ink and powder toner were used for printing.

Table 1. Composition of Model Offset Inks

Components of model inks	Ratio of components ink 1	Ration of components ink 2
Alkyd resin	10,0	10,0
Pigment	15,0	15,0
Additives	13,0	12,5
Mineral oil	28,5	-
Vegetable oil	5,0	39,0
Modified colophony resin	28,5	23,5

The used printing substrates were fine art glossy paper 120 g/m^2, fine art matt paper 120 g/m^2, offset paper 100 g/m^2 and recycled paper 100 g/m^2.

In all the measurements the standard methods were used. Some of the print series were artificially aged by 80^{0}C, 65% relative humidity in the period of 24 days.

Results and Discussion

Figure 2 presents the dependence of the color density on theoretical screen value of prints. The offset prints with standard coatings of model inks 1 and 2, the prints with model ink 2 with the decreased coating, so that the field with 90% of the screen value could be open, and the prints of Indigo and Xerox with usual ink coatings were observed.

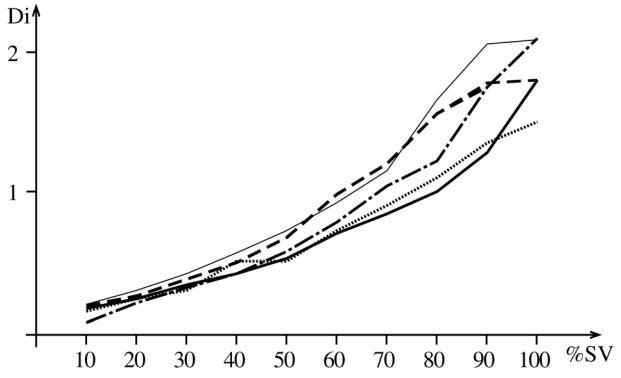

Figure 2. Dependence of the color density on theoretical screen value of prints

Conventional wet offset with ink 1
Conventional wet offset with ink 2
Conventional wet offset with ink 2 with open screen patch on 90% screen value
Digital offset printing Indigo
Digital printing Xerox

Curve which shows that the behavior of offset printing with ink 1 has the usual flow from which it can be seen that the field with 90% screen value is open. The curve obtained with measuring the prints printed with ink 2, which contains greater ratio of renewable raw materials in standard printing achieves the same density as with the ink 1 on solid area, but in these printing conditions 90% patch is closed. In order that 90% patch on the print would be open, it was printed with smaller ink coating.

The openness of this patch is achieved, but the whole curve is more straightforward and the color density of the solid patch is considerably smaller. The curve presenting the prints made in digital printing technique Indigo has usual flow. The patch with 90% screen value is open and the color density of the solid patch is greater than in conventional offset. The curve representing the events on Xerox prints has the usual flow up to 90% screen value. By visual checking, it was estimated that the patch is mainly open, but the measured color density is almost equal to the one on 100% patch.

It can be concluded from the diagram that the printing in offset by model ink based on mineral oil - ink 1, gives good results in all screen values. The use of the model ink 2 with greater ratio of the renewable raw materials has the consequence either to decrease the reproduction range or to decrease the printing possibility with greater degree of saturation. The prints are lighter. The digital offset Indigo gives great gradation range of color density with the uniform growth. The digital printing technique Xerox gives also great range of color density, but in the areas of great screen values (90 - 100%) the balance of color density appears, which decreases the quality of dark prints.

In all discussed cases, fine art glossy paper was used for printing. By applying other printing substrates, such as fine art matt paper, offset and recycled paper the described basic print characteristics were detained according to the tested printing techniques.

In the continuation of the research the changes of some optical and colorimetric properties of paper, i.e. prints caused by aging were observed. Figure 3 presents the influence of brightness on fine art glossy and matt paper as well as on offset and recycled paper before and after aging and all these paper kinds already aged after printing.

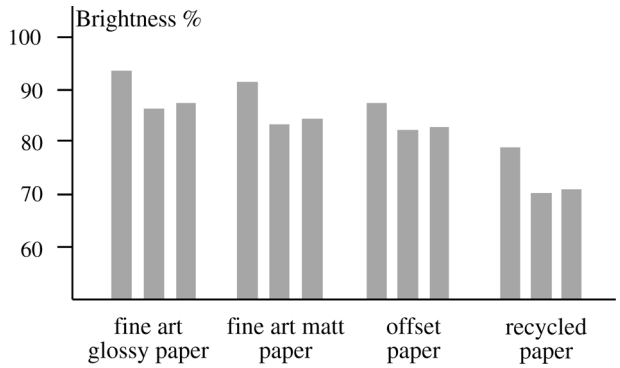

Figure 3. The aging influence on brightness of paper and prints

As it can be seen, brightness decreases during paper aging in all tested cases in the frame of the described experimental conditions. The causes of such phenomena could be oxidative decomposition of low molecular mass carbohydrates. Carbonile groups appear in such decomposition, they additionally influence the decrease of optical properties.

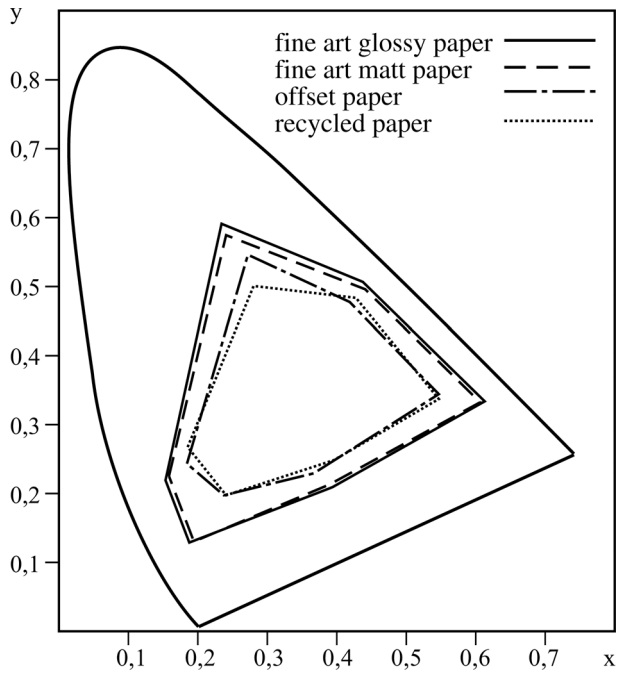

Figure 4. Spaces in CIE diagram covering by prints obtained with offset printing technique before ageing - ink 1

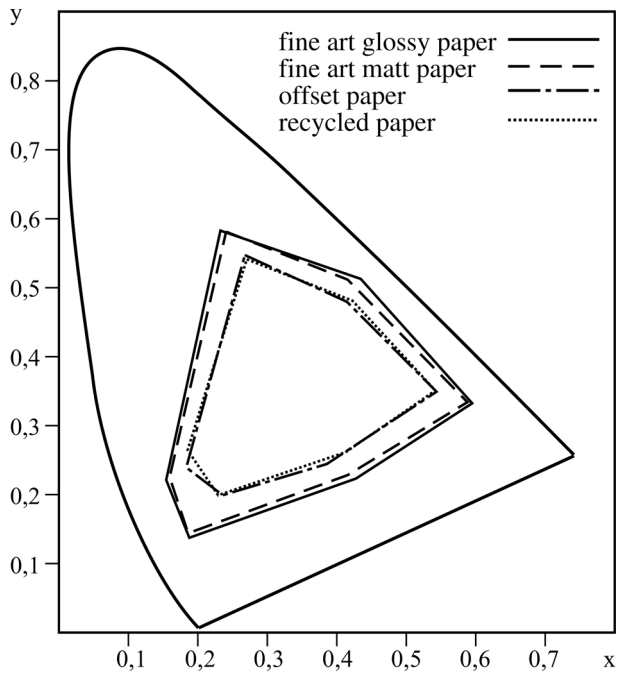

Figure 5. Spaces in CIE diagram covering by prints obtained with offset printing technique before ageing - ink 2

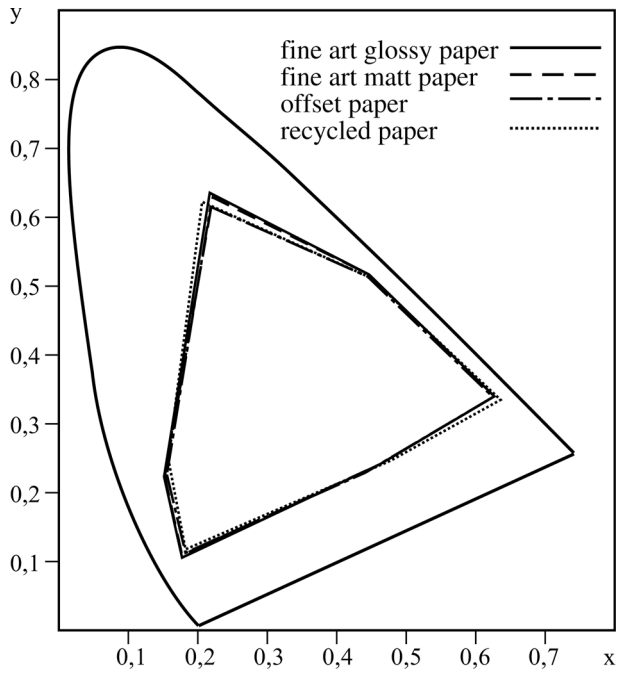

Figure 6. Spaces in CIE diagram covering by prints obtained with digital offset printing technique Indigo before ageing

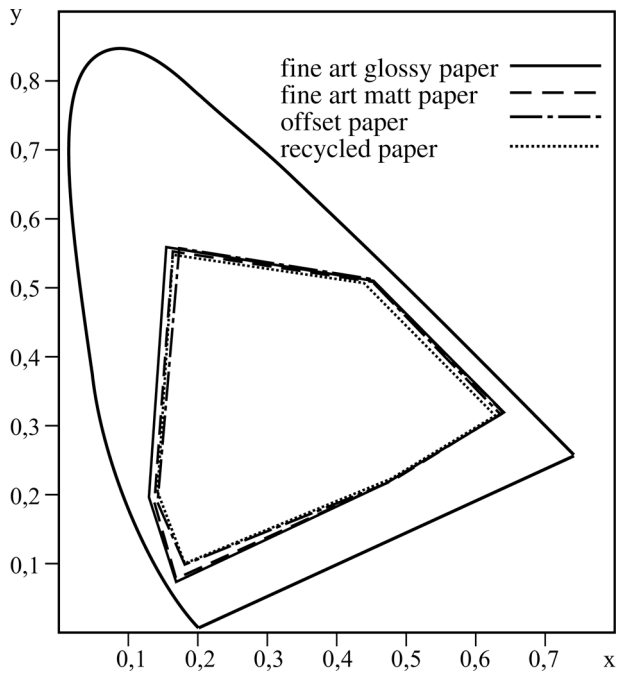

Figure 7. Spaces in CIE diagram covering by prints obtained with digital printing technique Xerox before ageing

Figures 4 to 7 present color spaces in CIE diagram covered by prints of the observed printing techniques on the determined printing substrates before aging, while the figures 8. to 11. present the same prints after artificial aging.

Figure 4 shows that the prints with model inks 1 based on mineral oil made in offset on fine art paper show considerably greater color area than the prints made on offset paper, especially on the recycled paper. Similar behavior have the prints in offset made with the ink 2 (figure 5), with greater ratio of renewable raw material, but the areas in CIE diagram covered by these prints are smaller. Figure 6 presents color area covered by the prints

of digital offset printing Indigo on all printing substrates, and the figure 7 presents the surface covered by the prints obtained by digital printing technique Xerox.

It can be noticed that these two printing techniques cover approximately the same great areas in CIE diagram with their prints, regardless the kind of the printing substrate. But it should be mentioned that the possibilities of these two printing techniques differ mostly in green area.

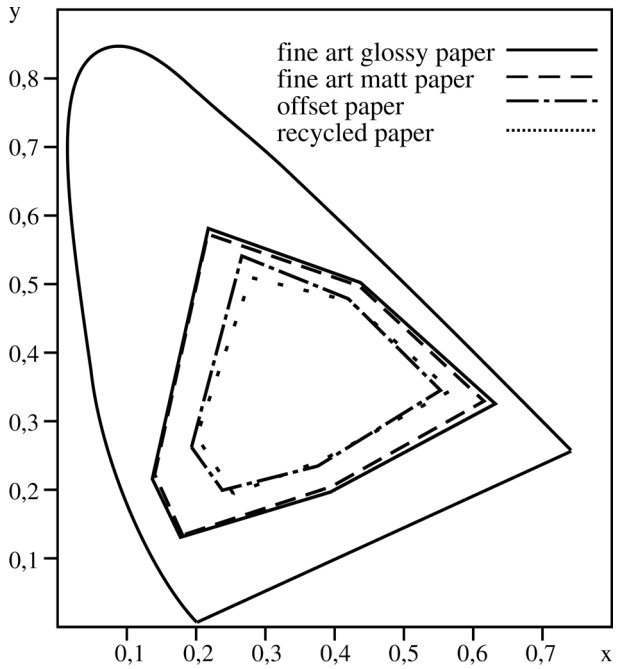

Figure 8. Spaces in CIE diagram covering by prints obtained with offset printing technique after ageing - ink 1

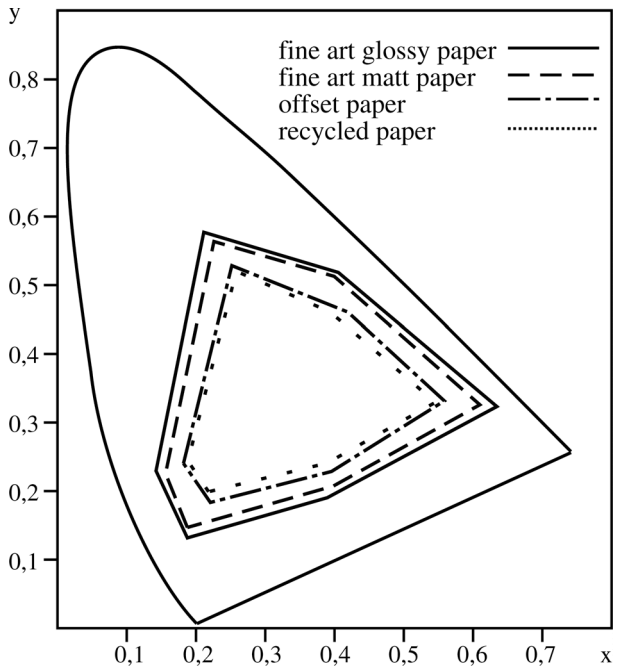

Figure 9. Spaces in CIE diagram covering by prints obtained with offset printing technique after ageing - ink 2

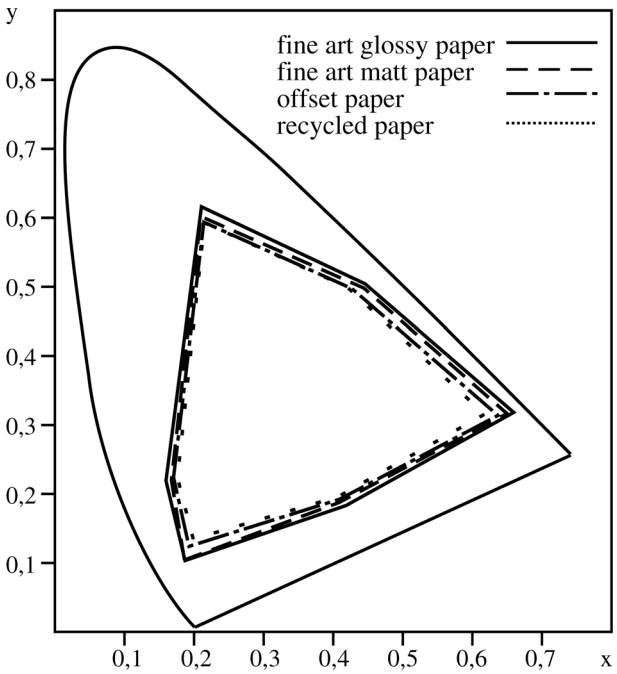

Figure 10. Spaces in CIE diagram covering by prints obtained with digital offset printing technique Indigo after ageing

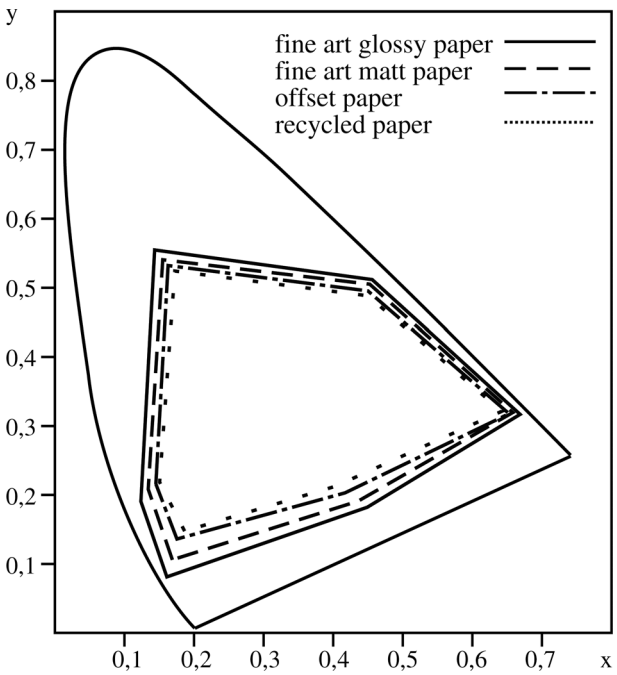

Figure 11. Spaces in CIE diagram covering by prints obtained with digital printing technique Xerox after ageing

In all the observed prints after aging, presented in figures 8 - 11, the common characteristic can be noticed. It is the change of durability of print color by the determined increase of inking gamut in the red area.

Other specific characteristics in regard to the kind of the printing substrate, ink and the printing technique are almost retained after the print aging as it was discussed before the aging.

Conclusion

It can be concluded that the investigations of some colorimetric and optical properties of paper, i.e. four color printed in conventional offset printing and with two different kinds of digital printing and durability by aging including the print quality, can be summed up as follows:

- Printing with model ink with greater ratio of renewable raw material has the consequence either the decrease of the reproduction range or the decrease of the printing possibilities with greater saturation degree. The prints are lighter.
- Prints made in digital offset printing technique Indigo give great range of color density gradations with uniform growth.
- With prints in digital technique Xerox in the areas of great screen values (90 - 100%) the balance of the color densities appear, which decreases the quality of the dark prints.
- By changing the printing substrate (fine art glossy and matt paper, offset and recycled paper) the relations of color density and screen value which are characteristic for tested printing techniques have been retained.
- By accelerated aging of paper before and after printing the brightness is decreased. The cause of these phenomena can be oxidative decomposition of low molecular mass carbohydrates.
- The color range in CIE diagram is considerably greater on prints in offset with the ink based on mineral oil in relation to the one with greater ratio of renewable raw material. The influence of the kinds of printing substrates is greater in relation to the digital printing techniques Indigo and Xerox.
- In accelerated aging of prints the increase of inking gamut in red gamut range can be noticed.

The results of the investigation will contribute to better knowledge of the influence of printing inks compositions and printing substrates on the print quality and the aging mechanisms.

They do not have only theoretical value, but also a practical approach in production and in the usage of prints.

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Biography

Mrs. Zdenka Bolanca is a full professor and a head of environment protection department with the Faculty of Graphics within the University of Zagreb. She teaches several undergraduate and graduate courses of Graphic engineering. She is engaged in the scientific research related to the processes and materials of graphic technology especially from the ecological aspect. She is the head of research project of the Ministry of Science and Technology. She collaborates with productive branches of economy and elaborates projects and expert analysis.