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SPb'06

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St Petersburg
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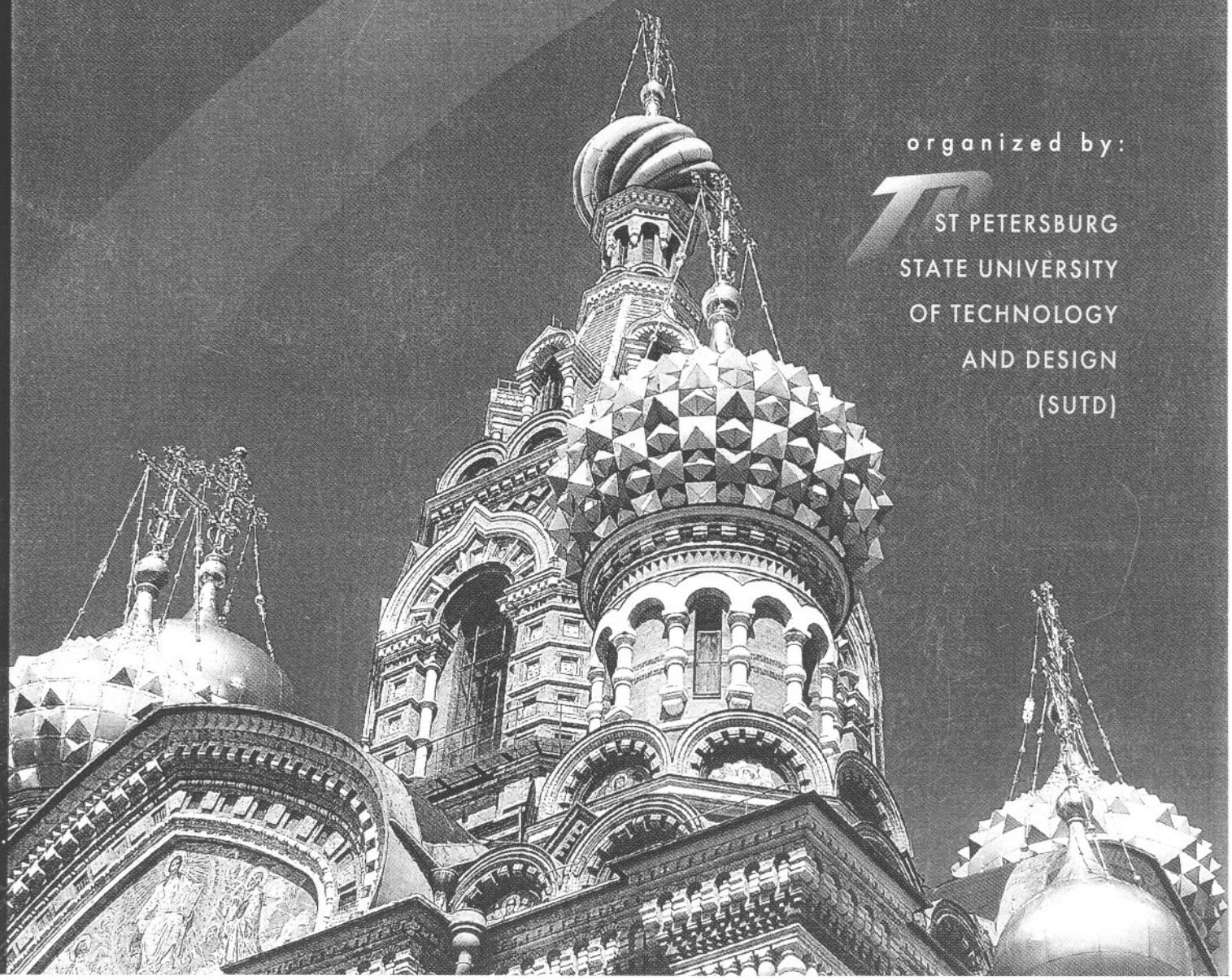

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Technical Association of Graphic Arts – TAGA (USA)

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INTRODUCTION

The Organizing and Program Committees along with all the cooperating Societies, are pleased to announce the Preliminary Program for the first International Printing Technology Conference.

There have been significant changes in the printing world. In addition to the continuing advances in traditional printing technology, the introduction of the computer-to-plate and computer-to-print systems, color management and computer integrated printing workflow are facilitating a more effective use of the open information environment both within the print production chain and the printer — customer — supplier communication chain. Up-to-date technologies are rapidly accumulated by the printing industries of Eastern Europe, the CIS and Asian countries.

«**Printing Technology SPb'06**» offers a unique experience, providing a worldwide discussion of related scientific and technical issues at one of the centers of this steadily growing printing market: Saint Petersburg. We will start each regular day with a Keynote Speech by industry leaders from Hewlett-Packard Laboratories, California Polytechnic State University and Eastman Kodak Company.

Two tracks will feature more than 70 technical papers by leading scientists from around the world that have been accepted for oral and interactive sessions. Papers will be presented in eight sessions of **Technical Program** within the parallel tracks.

Interactive Session will be comprised of oral previews within respective sessions followed by poster presentations on Wednesday afternoon. This session provides an opportunity for one-to-one interaction with authors.

The Monday **Tutorial Program** is packed with six tutorials on practical applications of printing technologies. Detailed descriptions can be found within this program.

From Tuesday to Thursday there will be an **Exhibition** of leading suppliers of software and instrumentation for control and investigation of print quality, printing process and materials.

The **Social Program** includes **Welcome Reception** Monday evening and **Conference Banquet** on Wednesday evening.

The official language of the conference is English. Tutorials and regular Conference tracks will be accompanied by translation into Russian.

Prof. Yuri V. Kuznetsov
Program Chair

Optical Characteristic Of Ink Jet Prints Conditioned By Substrate Ageing

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1. Abstract

The investigation results of optical characteristics and the relevant values essential for the quality of reproduction of the Ink Jet impressions in relation to the defined conditions of the accelerated ageing are presented in this paper.
The results show that the ageing process influences the optical properties of the printing substrate in the following sequence; recycled paper, fine art paper and offset paper. By analysis of FT-IR spectrum smaller increase intensity of the carboxyl peak can be noticed and the changes in the area, for which C=O vibrations are responsible, which is the result of the oxidation changes on aged paper in relation to the non aged paper. With prints on aged paper the greatest aberration in yellow and cyan happens on the fine art paper. Quick closing of screen in the printing is performed on the aged paper in relation to other sample series can be noticed.

2. Introduction

Papers, i.e. prints are subjected to many degradation processes during ageing. The ageing of paper could be in fact defined as a sum of all irreversible physical and chemical processes which happen in the material during time.
Deterioration in quality of an aged paper can manifest itself in chemical permanence and the decrease in mechanical durability [1, 2]. The permanence of paper or prints depends on the chemical resistance of its components and of the influence of external factors [3]. It includes lightfastness and points at resistance of the printing ink against fading and colour change after exposition to light [4, 5].
The durability of paper depends mainly on the physical and mechanical characteristics of the raw materials, impact of microclimatic factors such as heat, humidity or radiation and on contamination by ions and gas from the environment and action of microorganisms [6, 7].
Natural ageing process of paper and prints causes the degradation of cellulose .The presence of moisture, oxidative agents and microorganisms are important in this process and especially the presence of acidic substances. The results in this case are the hydrolysis of cellulose that appears in shortening its chain along with changes in content of crystalline form [8].
Acid catalyzed hydrolysis of cellulose was recognized to be the primary reaction of the accelerated deterioration of paper. For study of accelerated ageing of paper new methods are being developed and recently a mathematical model was presented for temperatures from Rychlyet at al [9].
Colorimetric characteristics of the non aged and aged paper printed by Ink Jet technology are presented in this work. The droplets of ink are sprayed through the nozzles on the substrate to obtain the image. The non aged and aged impressions have been analyzed as well. Relevant sizes essential for the reproduction quality as well as the results obtained by FT-IR spectroscopy have been discussed, in relation to the kind of the printing substrate.

3. Experimental

Digital printing machine Epson 1200 photo was used for printing. The test form contained different printing elements: coloured halftone photos, patches for determining the colour density, halftone value and relative printing contrast, trapping fields, patches for determining dimensional stability and colour register control, surfaces for determining grey balance and standard wedge.
The printing was performed on different substrates: fine art paper (Symbol Freelife Gloss, Fedrigoni), woodfree natural paper (Acroprint EW, Fedrigoni) and on recycled paper (PAN). Some paper characteristics are presented in table 1.

Table 1. Some characteristic of the used printing substrates

Sample	Composition	Grammage g/m^2	Thickness mm	Brightness
Fine art	Woodfree pulp 50% Recycled fibres 50% Both sides coated paper	110	0,098	95
Woodfree natural	Woodfree pulp, Noncoated	100	0,120	94
Recycled	Recycled fibres	80	0,110	86

For accelerated ageing substrate and print the climatic chamber was used, under the following conditions: temperature 80^{0}C, relative humidity 65% and ageing time of 24 days without the radiation influence. In the experimental part, three series of samples were processed: prints on non-aged paper, prints on aged paper and aged prints. Optical parameters for the described samples series were performed by X-Rite spectrophotometer with the support of ColorShop program. The measuring results were processed by means of Data Analysis program and technical Graphic Origin Professional. Except that the spectrophotometer Datacolor Elrepho 450 was used for measurements.
For monitoring and characterization the paper degradation caused by ageing the FT-IR spectroscopy was used (Spectrometer Spectrum One Perkin Elmer).

4. Results and discussion

It is possible to monitor the reproduction quality by the relation of the screen value of prints and original as presented for the impression on aged and non aged paper and aged impression in figure 1.

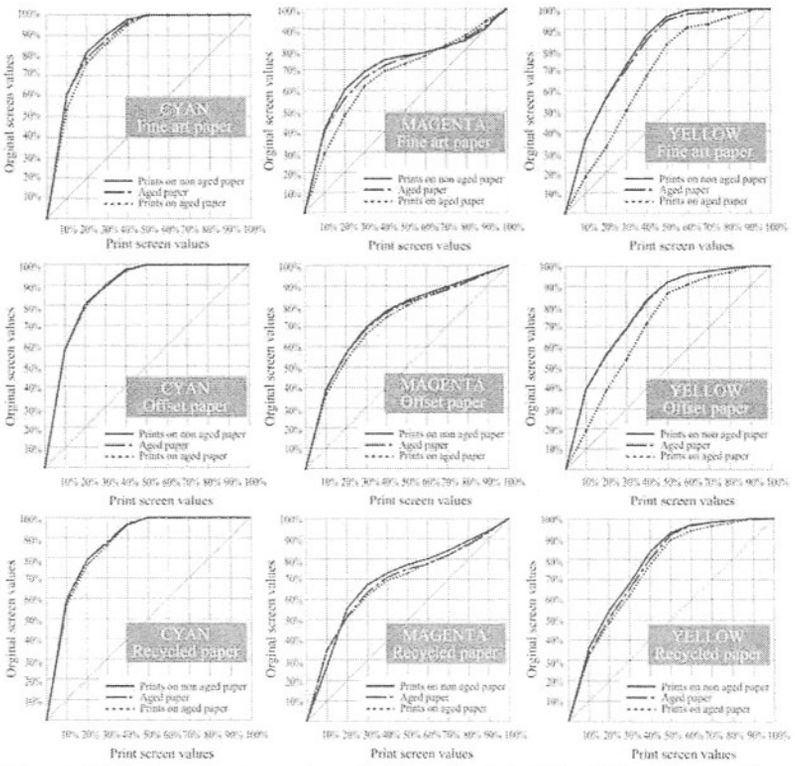

Figure 1. Relation of screen value of print and original for different types of paper

The research results show that in all the prints the positive error appears. Cyan is especially distinguished, in which the complete closing of screen appears at 50% of the screen value. Yellow colour behaves similar to that but it is less stressed and the closing of screen appears at 80% of the screen value. On prints on aged paper the MYK inks have the decrease of the screen value in relation to the non aged paper. On prints made on fine art paper, the decrease of the screen value ranges in the

area from 10 and 50% in the values between 20 and 15%, which essentially changes the print characteristics with the screen closing. The aged prints on offset paper do not show greater aberration in relation to the non aged prints. Prints on aged offset paper, particularly with yellow, show considerable decrease of the screen value along the whole reproduction curve with the greatest negative increase in the area of 20% screen value -16%. Prints on aged recycled paper have considerably expressed decrease of the screen value for CMYK in the area 20 and 60 % of the screen value in relation to the aged prints. Colorimetric values of all the print series in the whole ink layer are presented in figure 2 and the calculated colour differences ΔE are presented in table 2.

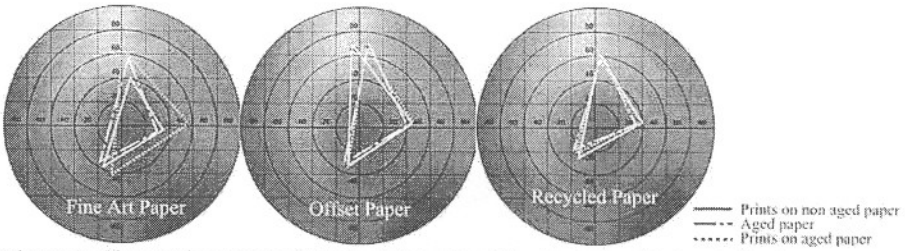

Figure 2. Chromatic values of aged prints and prints on aged and non aged paper

Table 2. Colour differences ΔE for CMY Ink Jet impressions

Sample	$C_{1,2}$	$C_{1,3}$	$C_{2,3}$	$M_{1,2}$	$M_{1,3}$	$M_{2,3}$	$Y_{1,2}$	$Y_{2,3}$	$Y_{2,3}$
Fine art	8,9	14,6	10,1	6,4	27,4	22,4	3,4	9,3	9,4
Offset	4,4	4,6	1,1	5,0	6,2	2,3	0,9	4,1	3,2
Recycled	8,2	4,1	4,7	6,0	6,4	3,1	3,5	4,7	4,3

$\Delta E_{1,2} = E_{\text{non aged prints}} - E_{\text{aged prints}}$, $\Delta E_{1,3} = E_{\text{non aged prints}} - E_{\text{prints on aged paper}}$, $\Delta E_{2,3} = E_{\text{aged prints}} - E_{\text{prints on aged paper}}$

It is visible from the results that the brightness of the Ink Jet prints changes very little in relation to the type of the printing substrate. The values of the chromatic parameters depend on the ageing process and the paper type.

In order to determine the possible influence of the ageing process of the printing substrate on total colour, which can be especially, expressed in brighter CMY tones, their optical properties have been monitored and the research results are presented in table 3.

Table 3. Colorimetric characteristics of the non aged and the aged paper

Sample	L*non aged	a*non aged	b*non aged	L* aged	a* aged	b* aged	Δ E
Fine art	95,97	1,51	-2,25	94,37	0,42	4,02	6,6
Offset	94,56	3,96	-8,83	93,88	2,89	-4,73	4,3
Recycled	86,73	-0,23	6,63	83,90	0,26	13,44	7,4

In ageing the printing substrate small changes in lighter – darker area can be seen, as well as the shift in red -green and in yellow -blue coordinate. Generally speaking the increase of b* value is attributed to the chromophores which appear by the degradation of the paper components such as cellulose, hemicelluloses and lignin.

In figure 3 FT-IR spectrum has been presented in the area of the wavelength numbers from 4000,0 do 400,0 cm^{-1} only for the non aged and accelerated aged fine art paper with the aim of determining the size of the influence in the changes of the observed optical properties which can originate from the degradation in the ageing conditions.

As it is visible from the results on the aged paper, the increase of the absorbency in FT-IR spectrum near 1600 cm^{-1} can be seen, which corresponds to the increase of the carboxyl peak and it is the result of the oxidation processes by ageing. Carboxyl groups have somewhat smaller effect on the decrease of the optical properties of the aged paper in relation to the carbonyl ones, but they increase their effect. In oxidative degradation of the low molecular part of the carbohydrates the carbonyl groups appear which effects the decrease of brightness and increase of yellowness of paper and the complex changes can be noticed in the area of the wavelength number of 1734 cm^{-1}, for which the vibrations C=O are responsible. The described changes are caused by the increase of temperature and relative humidity which corresponds to the microclimatic conditions of the accelerated ageing.

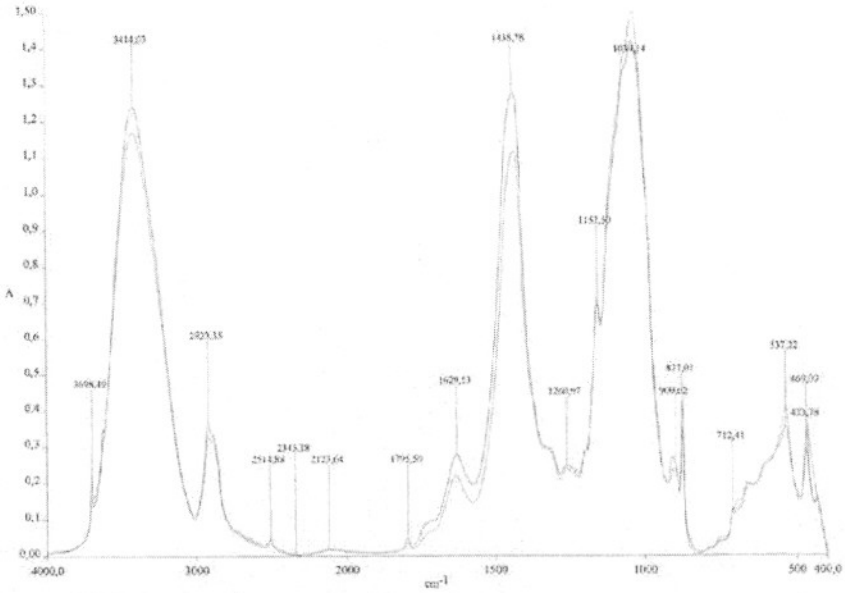

Figure 3. FTIR spectra of non aged and aged substrate

5. Conclusion

On the basis of the research results, it can be concluded that the ageing process influences the optical properties of the printing substrates in the sequence; recycled paper, fine art paper and offset paper. By the analysis of FT-IR spectrum smaller increase of the carboxyl peak intensity can be noticed as well as the changes in the area for which the C=O vibrations are responsible, which is the result of oxidation changes on the aged paper in relation to the non aged one.

Medium values of the colour differences for all the observed inks deviate somewhat greater for fine art paper (ΔE 12.4), and less for offset paper (ΔE 3.5) and recycled paper (ΔE 4.9). With prints on aged paper the greatest deviation appears in yellow and cyan on fine art paper. Quick screen closing can be noticed when printing is done on aged paper, in relation to other sample series.

In the scientific sense, this work is the contribution in explanation of the problems of reproduction ageing in Ink Jet technology including the relevant parameters of the reproduction process from the point of view of the formal characteristics of the printing form. The result application can contribute to the reproduction objectivity improvement.

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