THE EFFECT OF BASE PAPER PROPERTIES ON INKJET PRINT QUALITY

Juraj Gigac, Monika Stankovská, Michal Letko, Elena Opálená
Pulp and Paper Research Institute
Bratislava, Slovak Republic

ABSTRACT

The present work is aimed at a control of physical and chemical, as well as inkjet print properties of modelled paper by surface application of water-based polymer dispersions on two different base papers. The effect of polarity and specific charge density and hydrophobic effect of polymers as well as water-based inkjet inks on print quality was studied. The surface properties of paper depend not only on the type and amount of polymers but also on the fibrous matrix of the base paper. Water-based polymers applied on base paper prepared from virgin fibres significantly increased surface roughness and contact angle. Surface treatment of base paper from recycled fibres which are hornified and swelling less has not increased roughness, but reduced contact angle. At all modelled papers inkjet print quality was improved with increasing hydrophility of cationic polymers. At modelled recycled fibres based papers print density decrease was observed with increasing specific charge density of dye water-based inkjet inks.

KEYWORDS: Colour gamut, inkjet print, recycled fibres, roughness, surface sizing, wetting.

INTRODUCTION

Printing quality is strongly influenced by the structural and chemical properties of the paper surface and is one of the most important factors concerning costumer's evaluation. Surface sizing is a way how the wetting and the penetration of liquids into the paper can be controlled. Important is the equilibrium between internal and surface sizing for controlled penetration rate and lateral spreading of ink. The behaviour of ink drops on substrates depends of wetting of substrates and the flow of ink during the wetting process. The results of work (Moutinho et al. 2007) revealed that contact angles measurements are a valuable tool to predict paper's inkjet printing behaviour. Porosity and topology of pores, chemistry of surface together with surface energy and viscosity of liquids are playing an important role in surface paper interaction with liquids. Liquids can penetrate paper by action of external pressure forces or internal forces spontaneously sucking liquids into paper through capillary system. By applying of liquid droplet on paper surface a

different mechanisms of liquid reception occurs in relation to contact angle formed by liquid on paper surface. Surface wetting dynamics has been studied in great detail in the literature. A thorough review of dynamics of wetting and spreading may be found in several publications (Berg 1993, Daniel and Berg 2006). The problem of spreading on an impermeable solid substrate involves displacement of one fluid in contact with a solid by another fluid. Spreading can occur for both partial and complete wetting liquid-solid combinations, and, in both cases, spreading is driven by a lowering of the system free energy, caused by the destruction of solid-gas (SG) interface and the formation of additional solid-liquid (SL) and liquid-gas (L) interfaces. Whether or not a liquid wets a surface can be determined from the spreading coefficient $S_{L/SG}$,

$$S_{L/SG} = \sigma_{SG} - \sigma_{SL} - \sigma_L \tag{1}$$

Here σ_{SG}, σ_{SL} and σ_L are the surface energies of the solid-gas, solid-liquid, and liquid interfaces.

If $S_{L/SG} < 0$, the liquid is considered to be partially wetting and forms a finite equilibrium contact angle, Θeq, against the solid:

$$cos\,\Theta_{eq} = (\sigma_{SG} - \sigma_{SL})\,/\,\sigma_L \tag{2}$$

If $S_{L/SG} > 0$, the liquid is considered fully wetting and will spread to a thin film. The rate of drop spreading is determined by the processes that dissipate gains in free energy achieved by covering surface.

Surface roughness is one of the major causes of contact angle hysteresis (Good 1952). The contact angle of a liquid on a solid is strongly affected by any deviations of the surface from ideality, such as roughness. Wenzel (Wenzel 1936) identified a roughness ratio, r,

$$r = a\,/\,A \tag{3}$$

where: a - the actual microscopic area, and
        A - the apparent area, the projection of the microscopic area on a plane.

The Young-Wenzel equation is

$$cos\,\Theta_W = [\,r\,(\sigma_{SG} - \sigma_{SL})]\,/\,\sigma_L \tag{4}$$

where: Θ_W - the contact angle on the solid whose roughness ratio is r.

In the case that surface roughness will enhance the wetting of hydrophilic surfaces and reduce the wetting of hydrophobic surfaces. Differences of surface in chemical and morphological condition are causing hysteresis of contact angle values. As a result of roughness and porosity variability as well as of changes of hydrophilic and hydrophobic areas in paper the value of the static contact angle is between the receding contact angle (when air displaces liquid) and the advancing contact angle when air is displaced by liquid (Radvan and Skold 1966).

Cellulosic fibres can change significantly when wet formed into a wet web of paper and subsequently subjected to such processes as pressing, drying, printing, storage, re-pulping, and deinking. Some of the changes can be subtle. Often it is possible to substitute recycled fibres in place of virgin fibres used for the production of paper or paperboard. On the other hand,

characteristic differences between recycled fibres and virgin fibres (fresh from pulping wood, not recycled) can be expected; many of these can be attributed to drying. Drying is process that is accompanied by partially irreversible closure of small pores in the fibre wall, as well as increased resistance to swelling during rewetting (Hubbe et al. 2007).

As already shown (Lamminmäki 2012), in the inkjet ink setting process, it is desirable that the colorant part of ink fixes into the top layer of substrate and the ink vehicle part penetrates deeper into the structure. This takes the form of chromatographic separation in the case of dye-based inks (Donigian et al. 1998). In pigment-based inkjet inks, the separation takes place between colorant pigments and vehicle, where the ink pigments form a filter cake or agglomerate on top of the substrate (Donigian et al. 1998, Vikman and Vuorinen 2004, Svanholm 2007). In the ink separation, the controlling ink properties are thought to be the viscosity and surface energy (von Bahr et al. 2000). The surface properties of the substrate also affect the ink vehicle-colorant separation and movement (Desie and van Roost 2006, von Bahr et al. 2000, Glittenberg et al. 2003). The colorant adsorption can result in the forming of chemical bonds between the ink colorant and the different coating components. Lavery and Provost (Lavery and Provost 1997) named the possible bonds between the ink colorant and substrate in the order of decreasing strength of interaction: covalent bonding, Coulombic or ionic bonding, π-π interactions, hydrogen bonding, hydrophobic interactions, dipole-dipole interactions, and van der Waals forces.

Results from study (Svanholm 2007) have shown, what largely defines the applicability of an inkjet receptive coating is the print quality of the text or graphics printed on it. Among the most important inkjet quality factors are colour reproduction and print sharpness. Colour gamut measurement (the range of colours that can be produced by a given colour reproduction system) and various measurements of bleeding, such as line with (the uniform spreading of a printed line) and blurriness (the non-uniform spreading of a printed line) were carried out on prints on coated sheets. Print quality is an individual experience. The instrumental measurements must relate to the subjective perceptual impressions in order to be meaningful.

A significant effect related to polarity, specific charge density and hydrophobic effect of sizing agents on water fastness, print sharpness and optical density of modelled papers, prepared on base paper with 100 % content of virgin fibres was found by (Stankovská et al. 2014). By increasing polymer cationic charge and decreasing its hydrophobic affect, the printing parameters improved. Cationic and hydrophilic paper surface improves separation of dye and water from dye water-based inkjet inks. For water fastness as well as print sharpness, the fixation of anionic dyes is important by forming of complex with cationic polymer. For improving print density it is simultaneously necessary to increase wetting. Both these conditions are accomplished by styrene maleic anhydride copolymer sizing agents.

The objective of this work was to evaluate the effect of fibrous matrix on surface roughness, wettability (static contact angle and surface energy) and inkjet print quality of modelled papers, prepared by surface sizing with water-based polymer dispersions. Print quality was evaluated by several methods such as measurement of print density, colour gamut and print sharpness. This work is continuation of our previous work (Stankovská et al. 2014).

MATERIAL AND METHODS

Base paper samples

Commercial paper from 100 % virgin fibres of basis weight 157 $g.m^{-2}$ and commercial paper from 100 % recycled fibres of basis weight 93 $g.m^{-2}$.

Sizing agents

Commercial sizing agents were used in experiments. AKD is alkylketen dimer (Kemira); SA is styrene-acrylic acid copolymer (Kemira); SB latex is carboxylated styrene-butadiene-acrylonitrile copolymer (EOC Belgium Latex Division); SMAI 1000 is styrene maleic anhydride copolymer with styrene/maleic anhydride ratio 1/1 (Cray Valley); SMAI 3000 is styrene maleic anhydride copolymer with styrene/maleic anhydride ratio 3/1 (Cray Valley); SAE is amphoteric styrene-acrylic ester (AkzoNobel). Polarity positive or negative and specific charge density (SChD) of cationic or anionic sizing agents, dye-based inks and pigmented inks was determined by polyelectrolyte titration using the Streaming Current Detector (Waters Associates, Inc.). A cationic standard of 0.001 mol.l^{-1} polydialyldimethylamonium chloride (PDADMAC) solution and an anionic standard of 0.001 mol.l^{-1} sodium polyvinylsulphate (PVSNa) solution were used. The measured data of sizing agents are in Tab. 1.

Tab. 1: Specific charge density of sizing agents.

	AKD	SA	SB latex	SMAI 1000	SMAI 3000	SAE
Specific charge density of sizing agent, µeq.g^{-1}	+ 1750	- 92	- 177	+ 2764	+ 2166	- 7.5

Testing liquids

Deionised water, 16 % aqueous solution of isopropyl alcohol (IPA), water-based dye and pigmented inks.

Surface sizing

Surface sizing of base papers was performed in a laboratory size press (Werner Mathis AG, Swizerland) at constant speed of paper of 5 m.min^{-1} and linear pressure of 20 kN.m^{-1}. Aqueous solutions properties of sizing agent at temperature of 23°C: concentration of 17 %, outflow time of solutions from a Ford Cup No. 4 (Viscosimeter) of 11-12 s, pH value was in the range of 3.5-7.8. Dry matter uptake of the sizing agent were calculated from the wet matter uptake and concentration of solution applied to the base paper surface in size press. Modelled papers were dried 3 min at a temperature of 105°C. The content of sizing agent (dry matter uptake) in modelled papers was of 0.1-0.5 %.

Properties of inkjet inks

The anionic specific charge density (*ASChD*), dynamic viscosity, volume density and surface free energy inkjet inks PIXMA (dye inks CLI-521 Y, CLI-521 C, CLI-521 M, CLI-521 BK and of a pigmented ink PGI-520-BK) are presented in Tab. 2. Details of these parameters measurement is in our previous paper (Stankovská et al. 2014).

Tab. 2: Specific charge density, surface energy, dynamic viscosity and volume density of dye and pigmented water-based inks.

Liquids at 23°C	CLI-521 M	CLI-521 BK	CLI-521 Y	CLI-521 C	PGI-520 BK
Specific charge density µeq.g^{-1}	- 289	- 259	- 191	- 137	- 16
Surface energy mJ.m^{-2}	36.5	39.5	37.1	37.6	41.2
Dynamic viscosity mPa.s	2.67	2.61	2.46	2.43	2.46
Volume density g.cm^{-3}	1.11	1.09	1.09	1.10	1.07

Dynamics of liquids absorption

Ultrasound intensity (USI) change was measured by the PDA C.02 ultrasound analyzer (Emtec, Radnor, PA, USA) within a period of 34 ms-30 s from the contact of base papers and modelled papers surface with liquids. Testing liquids (surface energy σ, dynamic viscosity η at a temperature of 23°C): deionised water (72.8 $mJ.m^{-2}$, 0.9 mPa.s), 16 % aqueous solution of isopropyl alcohol IPA (44.2 $mJ.m^{-2}$, 1.1 mPa.s). At the contact of liquid with surface, inhibition (a dynamic process of liquid absorption by a substance) occurs, involving phenomena such as wetting, penetration, diffusion, and swelling. Ultrasound measurement of this dynamic process enabled an assessment of difference in the quality of uncoated and coated papers (Gigac et al. 2011, 2013). In this study of interaction between papers and liquids, the following properties were evaluated: Degree of sizing (t_{max}) by the time required for maximum USI at contact with paper with water and fine-pores content (t_{95}) by the time required for reduction of USI from 100 to 95 % at the contact with paper with 16 % water solution of IPA.

Wettability

Contact angle, as well as surface energy of liquids and paper was measured using the optical tensiometer (OCA 35, Dataphysics Instruments GmbH). Contact angle was measured by the sessile drop method. Wetting time was recorded by a CCD camera at the sequence 20 frames per second from the first contact of a liquid drop with paper surface in a time from 3 ms to 5 s. Contact angle was calculated as the average of ten parallel measurements. Deionised water was used for contact angle measurements. Three testing liquids (diiodomethane, ethylene glycol, thiodiglycol) with different surface tension were used to determine surface free energy (SFE) and surface dispersive energy of paper. SFE as well as the corresponding disperse and polar parts were calculated by the Owens-Wendt-Rabel-Kaelble method using values of static contact angles. Pendant drop method was used to determine surface energy of the liquids. Measurement of modelled papers contact angle as well as of base paper is described in our previous papers (Gigac et al. 2014, Stankovská et al. 2014). In our study, we applied the static contact angle in a time of 5 ms.

Topography of paper surface

Roughness and topography of paper surface was measured by the photoclinometric method. Photoclinometry in the visible range of electromagnetic radiation (Dahl et al. 2006) is a promising method useable for on-line measurement of paper roughness. It describes the transformation of 2D surface image to a map of different levels of height. The incident light creates shadows (different grey values). According a well-known and patented method (Johanson and Hanson 2004) the paper is illuminated from left and right at an 14° angle. Paper is an anisotropic material, therefore it is necessary to obtain surface images from at least two directions (machine direction and cross direction). The paper surface in our work was scanned using a Nikon CCD Coolpix E4500 camera by inclined illumination at 10° from six directions (in machine direction and five-fold 60° rotation of the sample) and the approximate height of points was calculated. The measurement system of photoclinometry consists of a lighting source illuminating the paper at an angle of 10° and of a camera which scan the lighted part of the sample, as shown in Fig. 1.
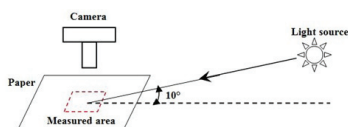
Fig. 1: System of photoclinometry.

Fig. 2: Printing test sheet with test elements. (Measured print areas and parts of text are marked by circles.).

A fourfold magnified image of the size 1704 x 2272 pixel was evaluated. The scanned image is converted to 256 shades of a grey scale according to approximate heights of points. The histogram is obtained in the range from 0 to 255, where 0 is the darkest colour (black), 128 is the mean value of grey and 255 lightest (white) colour. Standard deviation and mean (grey value) is automatically calculated from the histogram. Further the optical surface variability defined by a coefficient of variation expressed in percentage (OVS_{CLINO}) was determined (Kasajová and Gigac 2013).

Inkjet printing

Base and modelled papers were printed with process colours (dye inks CLI-521 Y, CLI-521 C, CLI-521 M, CLI-521 BK and with a pigmented ink PGI-520-BK) by the Canon Pixma i4700 thermal printer in the mode Plain paper. The printing test sheet (Fig. 2) contains several test elements, e.g., full colour areas (cyan, magenta, yellow, black, green, blue, red and orange) of dye inks; the text printed by yellow dye ink on a black background and the text printed by black pigmented ink is on yellow background.

Print density and colour gamut

The test form used is shown in Fig. 2. Print density of colour areas was measured by the QUIKDens 100 densitometer. L*, a*, b* values were measured using an Elrepho spectrophotometer (Lorentzen & Wettre, Sweden). Colour gamut is the range of colours that can be produced by a given colour reproduction system. The gamut value was obtained from the a* and b* values of the 100 % cyan, magenta, and yellow blocks together with those for the secondary (200 %) green and orange blocks, and was calculated as 2-dimensional colour gamut area in (a*, b*) space - pentagon.

Print sharpness

The print sharpness on surface treated modelled sheets was evaluated as deformation of the letter "s" in the text (Fig. 2). The digitalized image of the printed surface area was captured using a CCD Coolpix E4500 camera with an adapter for homogenous lighting. Dimension of the analysed image was 274 x 460 pixels. For calculation of print object deformation the fractal

analysis of the HarFA 5.3 software was used (Nežádal et al. 2000). The object deformation (rL/rS) is calculated from the ratio of the perimeter radius and the area radius of the letter "s". Deformations of yellow letter on black background were evaluated. Image thresholding was performed in broader range and dependence of letter „s" deformation on GL was evaluated. GL value 130 for evaluation was selected in the field of small deformation changes (plateau). The decreasing deformation of printed object indicates improved print sharpness. A detailed description of the method is in our previous paper (Stankovská et al. 2014).

RESULTS AND DISCUSSION

Most inkjet inks are anionic, as surface of a base paper. If the ink is absorbed into sheet too rapidly, it can lead to poor print density and, thus, strike-through in the print. On the other hand, if the ink is not absorbed quickly enough, it may spread laterally, resulting in colour-to-colour bleed, edge raggedness, and line broadening. These requirements are contradictory, and an appropriative trade-off between these two effects is needed. This is achieved by manipulating the sheet´s porosity and absorbency characteristics, by sizing or coating (Swanholm 2007). In Tab. 3, physical (roughness, water contact angle, surface energy, sizing degree, fine-pores content) and printing properties of both base papers are specified. Roughness of base paper from recycled fibres in comparison with base paper from virgin fibres is higher, the paper is more sized (higher value of t_{max}, higher water contact angle and lower surface energy) and has significantly more small pores (t_{95}). These are sufficient reasons to achieve a higher gamut area by 280 units.

Tab. 3: Physical and printing properties of base papers.

Properties	Base paper from virgin fibres	Base paper from recycled fibres
Basis weight, $g.m^{-2}$	157	93
Apparent density, $g.cm^{-3}$	0.86	0.86
Roughness PPS, µm	4.7	6.0
Water contact angle, °	82.7	109.3
Surface free energy, $mJ.m^{-2}$	38.0	26.9
Surface dispersive energy, $mJ.m^{-2}$	37.8	26.0
Sizing degree for water t_{max} , s	0.87	1.50
Fine-pores content for IPA t_{95} , s	0.08	0.66
Colour gamut area	4272	4550
Deformation of letter (Print sharpness)	5.8	6.2
Print density of yellow	1.003	1.130
Print density of cyan	1.170	1.010
Print density of magenta	1.130	1.190
Print density of black	1.550	2.270

Influence of surface treatment with water solution of polymers on surface roughness depends on type of fibres in the base paper. With respect to virgin fibres swelling in water, surface roughness of paper increased especially in case of lower polymer content in the range 0.1-0.3 % (Fig. 3 A). Recycled fibres in the base paper (Fig. 3 B) are not increasing surface roughness as the fibres are hornified and swell less. Higher polymer content has the ability to reduce surface roughness of modelled papers.
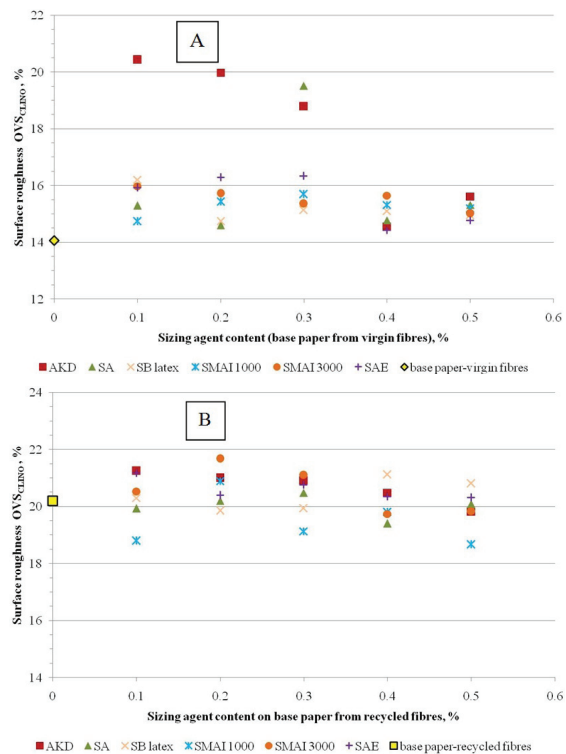
Fig. 3: Effect of water based polymer dispersion on surface roughness by surface sizing of base paper from virgin fibres A) and recycled fibres B).

Increase of paper roughness at low content of sizing agent (0.1 %) resulted in increased contact angle (Tab. 4 A). Hydrophobic effect of sizing agents increases in the sequence SMAI 1000, SMAI 3000, SAE, SB latex, SA and AKD. In case of base paper from recycled fibres (Tab. 4 B) the sequence is analogous. The lowest contact angle was achieved at surface sizing with SMAI 1000.
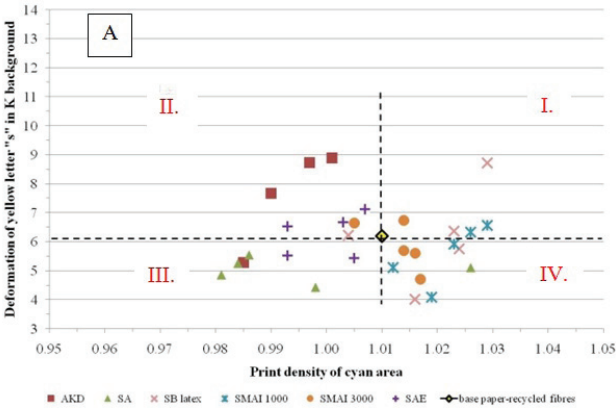
Tab. 4 A: Effect of sizing agent content on water contact angle (in °) of modelled papers from virgin fibres (water contact angle of base paper from virgin fibres of 82.7°).

Sizing agent content %	AKD	SA	SB latex	SMAI 1000	SMAI 3000	SAE
0.1	133.6	110.5	101.9	93.5	99.8	102.8
0.3	135.4	98.4	95.5	95.9	101.1	108.4
0.5	135.2	102.7	106.2	95.2	97.0	105.9

Tab. 4 B: Effect of sizing agent content on water contact angle (in °) of modelled papers from recycled fibres (water contact angle of base paper from recycled fibres of 109.3°).

Sizing agent content %	AKD	SA	SB latex	SMAI 1000	SMAI 3000	SAE
0.1	135.8	104.1	110.2	91.5	99.7	113.3
0.3	140.8	108.4	93.2	95.0	105.8	117.5
0.5	140.0	109.2	97.5	92.6	102.4	114.7

Fig. 4 shows print density and letter deformation printed of base paper and modelled papers with 0.1-0.5 % sizing agent content. Each of the diagrams on Fig. 4 is divided into four sectors (I-IV) with dotted lines which pass through the yellow rhombus. The coordinates of the yellow rhombus represent the printing properties of the base paper. In the sectors I and II modelled papers are located with increased deformation of text compared to base paper; in the sectors II and III are papers with reduced print density; in sectors III and IV are modelled papers with reduced deformation of text and in the sectors I and IV are modelled papers with increased print density. In the fourth sector, modelled papers of highest print quality are located when compared with base paper. In this sector modelled papers are located with increased print density and print sharpness (reduced text deformation) when compared with base paper. In both evaluated base papers, sizing agents SMAI 1000 a SMAI 3000 were more successful. That stands in full scale only for the case A. The reason of this result is a high cationic specific charge density of polymers (Tab. 1) and simultaneously a lowest sizing effect (Tab. 4). In the case of surface sized base paper prepared from recycled fibres significant influence of specific charge density of dye water-based inks on print quality of modelled papers was observed. Highest print quality (sector IV) was achieved by application of cyan inkjet ink. Print density stepwise decreased with increase of anionic specific charge density (*ASChD*) of inkjet inks (Tab. 2) from –137 to –289 $\mu eq.g^{-1}$, in the sequence colour print areas cyan, yellow, black and magenta (Fig. 4 A-D). In the case of surface sizing of base paper from virgin fibres with SMAI 1000 such a strong influence of specific charge density of inkjet inks on print density was not observed.
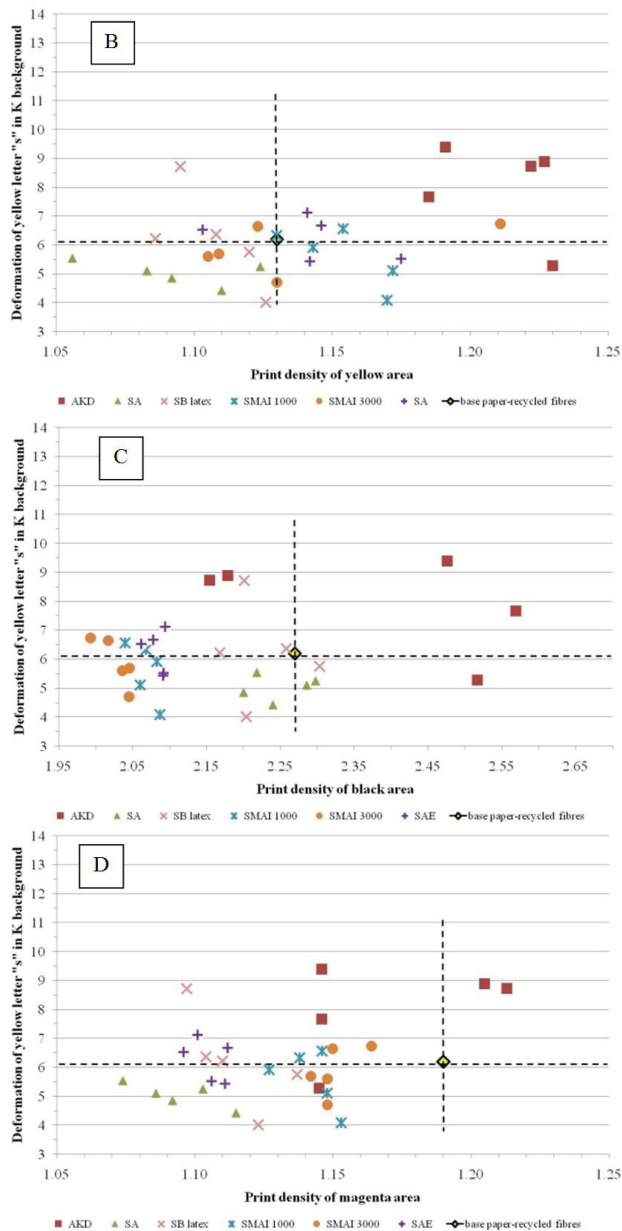
Fig. 4: The effect of sizing agents on dye yellow letter deformation on black background and on print density of colour print areas. Base paper from recycled fibres, modelled papers with 0.1–0.5 % sizing agent content. ASChD of inkjet ink: cyan –137 A), yellow –191 B), black –259 C) and magenta –289 µeq.g⁻¹ D). (Sectors: I–II reduced print sharpness, III–I increased print sharpness, II–III reduced print density, and I–IV increased print density).

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On Fig. 5, colour gamut of two modelled papers and, for comparison, one matt coated inkjet paper are shown. Colour gamut area is expressed by the area of pentagon created by colour coordinates (a*, b*) of cyan, magenta, yellow, green and orange print areas. A larger area corresponds with a higher printing quality. The blue pentagon belongs to surface sized base paper from virgin fibres and the red pentagon belongs to surface sized base paper from recycled fibres. The green pentagon belongs to matt coated inkjet paper.
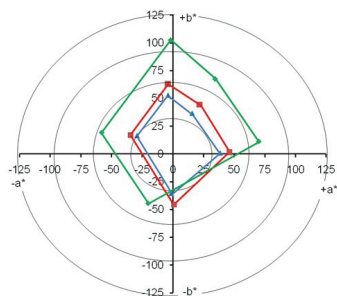

Fig. 5: Colour gamut of surface sized papers and matt coated inkjet paper. Base paper from virgin fibres sized with 0.1 % AKD (blue), base paper from recycled fibres sized with 0.1 % SMAI 1000 (red), matt coated inkjet paper (green).

Fig. 6 shows influence of surface sizing of two base papers with sizing agents AKD, SA, SB latex, SMAI 1000, SMAI 3000 and SAE (0.1 %) on static contact angle, surface dispersive energy and colour gamut area of modelled papers. In the correlated equations, symbol y means colour gamut area (causes A, B), symbol x means static contact angle in the case A and surface dispersive energy in the case B. Relationship between colour gamut area and water contact angle (6A) and surface dispersive energy (6B) was in most cases excellent. Base paper from virgin fibres (yellow rhombus) had a colour gamut area of 4272 and from recycled fibres (yellow square) of 4550. Both modelled papers achieved a higher colour gamut area (4666 and 4625) and are illustrated in green area, when compared with base paper from recycled fibres (yellow square). Colour gamut area of modelled papers with 0.1 % AKD on base paper from recycled fibres was 4125 and on base paper from virgin fibres was 3434 (in violet area).
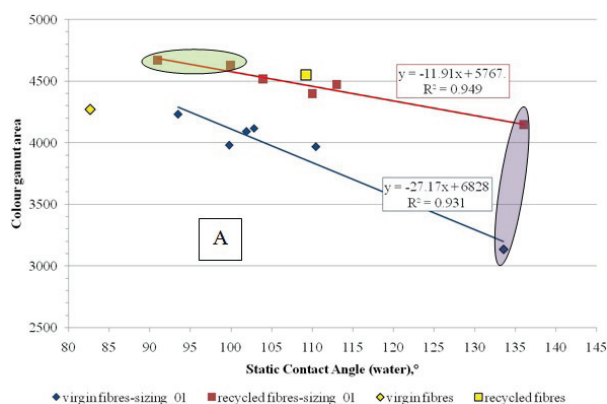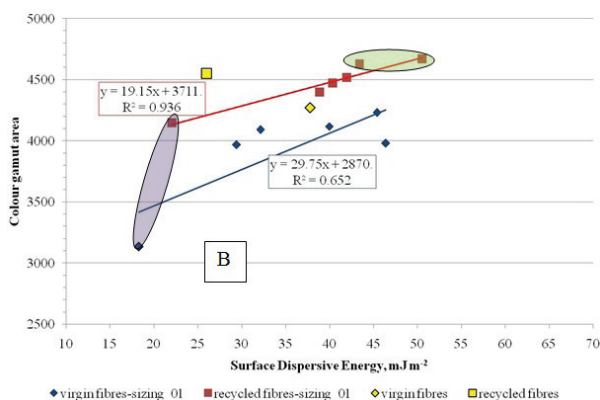
Fig. 6: Effect of 0.1 % sizing agents on colour gamut area, static contact angle A) and surface dispersive energy B) of modelled papers. Base paper from virgin fibres (yellow rhombus) and modelled papers (blue rhombus). Base paper from recycled fibres (yellow square) and modelled papers (red squares).

CONCLUSIONS

The evaluated base papers were prepared from various fibres (virgin and recycled fibres) and differed in basis weight, roughness, wettability, sizing degree, fine pores content and print quality. Significantly higher amount of fine pores and sizing degree from recycled fibres were sufficient enough to achieve a higher colour gamut area by 280 units.

It was confirmed that by increasing the surface sizing agent cationic charge and decreasing its hydrophobic effect printing parameters improved. For water fastness as well as print sharpness, the fixation of anionic dyes is important by forming of the complex with cationic polymer. Already a lower content of sizing agents on modelled papers was sufficient enough to improve surface sharpness. Increasing the sizing agent content resulted in an increase of contact angle and a decrease of modelled papers surface roughness. Low surface dispersive energy of modelled papers negatively influences wetting and spreading inkjet inks on surface, print density and colour gamut.

Important influence of the base paper fibrous matrix on the properties of surface sized inkjet paper was found. Water-based sizing agents are causing swelling of wood fibres, increased porosity and surface roughness of the modified paper. Highly swellable virgin fibres in the base paper extremely increase surface wetting contact angle by water of a higher roughness paper especially at lower addition of more hydrophobic sizing agents. Increased contact angle and reduced surface dispersive energy already at low addition of sizing agents respectively doesn't render a possibility to improve print density and colour gamut of the base paper from virgin fibres as it is in the case of surface sizing of base paper from recycled fibres.

Surface sizing of the base paper from recycled fibres doesn't change significantly surface roughness what is related to low swelling of hornified recycled fibres. This enabled by surface sizing of base paper with 0.1 % SMAI 1000 or SMAI 3000 to prepare modelled papers with higher print quality parameters such as print sharpness, print density and colour gamut as has the base paper.

In the case of surface sized base paper from recycled fibres, an important influence of specific charge density of dye water-based inks on print density of modelled papers was observed. Print

density stepwise decreased with increasing anionic specific charge density of inkjet inks from -137 to -289 µeq.g^{-1}.

The present research of inkjet paper preparation with improved printing properties continues. There will be used the combinations of cationic polymers, adhesives, silica and calcium carbonate pigments.

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Juraj Gigac, Monika Stankovská, Michal Letko, Elena Opálená
Pulp and Paper Research Institute
Lamačská Cesta 3
841 04 Bratislava
Slovak Republic
Corresponding author: gigac@vupc.sk