Study of printability of new types of coated printing paper made from 100% recycled fibres

Stefan Jakucewicz[1], Ján Panák[2], Karol Henryk Dreszer[1]
[1]Division of Graphic Art Technologies, Institute of Mechanics and Printing, Faculty of Production Engineering, Warsaw University of Technology,
e-mail: sjakucewicz@kpp.pl
[2]Division of Graphic Arts and Applied Photochemistry, Institute of Polymer Materials, Faculty of Chemical and Food Technology, Slovak University of Technology
e-mail: jan.panak@stuba.sk

Abstract: *The aim of this work was to evaluate the printability characteristics of the three types of coated paper made from recycled fibres in offset printing and to compare them with high-quality wood-free coated paper. Printing from test form was made on the sheet-fed offset B2 machine format. Inking was adjusted according to ISO 12647-2:2004. On the printed sheets were evaluated* $-\Delta E_{ab}$ *primary and secondary colours to the reference values,* D^{100} *CMYK inks, tonal value increase* ΔA_T*, trapping and reproduction of fine elements. Based on these results we can say that the studied papers are in terms of printability exactly the same as high quality standard wood-free coated paper.*

Keywords: *recycled fibres, printing papers, offset printing, printability*

Introduction

Recycled fibres produced from recovered paper are used more and more in modern papermaking. Using recycled paper does not save trees. Most fibre for paper comes from managed forests in which tress are a crop, planted for the purpose of providing timber. Sustainable forest management looks beyond financial considerations and embraces environmental concerns – protecting ecosystems and biodiversity – and also social concerns, both for workers and local people. Papermaking fibres can typically be recycled 5–7 times before they become too short to be recycled again. The strongest reasons for recycling paper are that it is a more efficient use of our resources and it reduces waste. Every tonne of recycled paper usually leaves about 100–150 kg of residue in the form of de-inking waste, which is most commonly burned for energy production. The production of recycled paper uses 50 % less water and reduces air pollution by 74 %, compared to the production of new, virgin paper. Recycled paper requires between 30–70 % less energy to make. Every ton of 100 % post-consumer recycled paper made instead of virgin paper saves approximately 30,000 litres of water and 3 –-4,000 KWh of electricity. The energy savings also mean a significant reduction in carbon CO_2 emissions.

Printability is the quality potential of paper in printing. Printability parameters are measured as optical, colorimetric and mechanical print properties. Printability is the result of interactions between paper and both the printing ink and printing press. In the early 1980s when recycled papers were being developed, they were hard to use on press and in copiers. Today, however, recycled paper performs quite well though there may be some minor aesthetic issues (such as lower brightness than virgin paper).

The aim of this work is to investigate a printability of three types of coated papers made from 100 % recycled fibres in and to compare them with high-quality wood-free coated papers.

Experimental

We used two types of wood-free papers – UPM Finesse Gloss, UPM Finesse Silk and three types of 100 % recycled papers – Cocoon Gloss, Cocoon Silk and Cyclus Print. Their parameters are in table 1.

UPM Finesse papers offer high whiteness and brightness, opacity 90–100% and different finishing from gloss to matt. Its superior surface provides the best image and text reproduction, ensuring you can make a sharp and lasting impression. They are made from hardwood and softwood sulphate pulp. Their end use is advertising material, annual reports, books, brochures, catalogues, direct mailing, magazines covers, magazines, newspaper supplements, personalized direct mailing.

Cocoon is the innovative range of extra-white 100% recycled papers, FSC® Recycled certified. Arjowiggins Graphic was the first European paper manufacturer to launch a 100% recycled, extra-white coated paper for graphical applications – Cocoon Silk and Gloss. They are suitable for a range of applications. Cocoon Gloss and Cocoon Silk are guaranteed for offset printing and suitable for most digital press systems, including HP Indigo.

Table 1: The paper used for printing (basis weight of papers was 200 g/m²)

Type of paper	Brightness D65 (%)	Thickness (mm)	CIE Whiteness (%) ISO 11475	Gloss Hunter (%)	Smoothness/PPS ISO 8791-4 (μm)	Opacity ISO 2471 (%)
UPM Finesse Gloss	99.5	0.15	130	79	–	98.5
UPM Finesse Silk	101	0.18	129	79	–	99
Cocoon Gloss	–	0.14	124	74	–	99
Cocoon Silk	–	0.18	124	32	–	99
Cyclus Print	–	0.19	89	–	3.7	>98

Huge investment in the Danish pulp mill and its sister paper mill has converted both units to production entirely dedicated to making Cyclus papers from 100 % post-consumer recycled waste. Fully coated both sides with a whiteness achieved without optical brightening agents. Cyclus Print is a 100 % recycled matt-coated, natural white fine printing paper for use in both full colour and black and white printing. The non-reflective matt surface is especially suitable for publications with a combination of large text areas and high quality pictures. Cyclus Print paper is suitable for a range of applications (depending on grammage): catalogues, magazines, brochures, promotional prints, posters, direct mail, etc. Cyclus Print is suitable for offset, dry offset and web offset with heat-set drying.

Test form printing plates were prepared by CTP technology using Kodak Magnus 400 III Quantum Platesetter and thermal Kodak Electra XD plates. Prints were printed on sheet-fed five-color offset press Manroland, model 505 HiPrint LV. Sheetfed offset CMYK inks Novaboard 4 C 990 PROTECT BIO (Flint Groop K+E) were used. Inking was adjusted according to ISO 12647-2:2004.

Papers were printed in the following order: UPM Finesse Gloss, Cocoon Gloss, UPM Finesse Silk, Cocoon Silk and Cyclus Print. 500 sheets of each type of paper have been printed. From these 500 sheets 20 of them were randomly selected for printability parameters measurements.

Evaluated printability parameters were:

- solid ink density of CMYK colours (ISO status E, pol, pap, black backing),
- colour difference ΔE_{ab} of primary and secondary colours (D50, 2°,abs,nonpol, black backing) has been calculated from measured CIE L*a*b* values and reference values from ISO 12647: 2004
- dot gain ΔA_T
- trapping
- grey balance
- paper L*a*b*
- dimensional stability of paper during printing (register)
- visual quality of prints

Presented values are means from 20 measured or calculated values.

Results and discussion

Solid inks densities. The mean values of solid inks densities are in table 2. The values of densities for selected process colour are very similar for all tested papers. Values for black are the highest and for yellow the smallest ones. It can be concluded that all the papers are very similar.

Table 2: Solid inks densities of process colours

	UPM Gloss	Cocoon Gloss	UPM Silk	Cocoon Silk	Cyclus Print	12647-2: 1996 (P1)
Cyan	1.46	1.37	1.40	1.37	1.37	1.55±0.05
Magenta	1.38	1.38	1.3	1.37	1.37	1.50±0.05
Yellow	1.23	1.24	1.23	1.23	1.18	1.45±0.05
Black	1.77	1.90	1.86	1.80	1.80	1.85±0.05

CIELAB colour difference ΔE^*_{ab} primary (CMYK) and secondary colours (RGB). The calculated values are in table 3. The allowed tolerance for the solids of the process colours according to ISO 12647-2:2004 is 5. Same of the colour differences are higher than 5. The deviations are not large enough to disqualify the test papers for the printing industry. The values of ΔE_{ab} of secondary colour are relatively higher than the primary one, which is quite normal phenomenon.

Table 3: Colour differences ΔE_{ab} primary and secondary colours

	UPM Gloss	Cocoon Gloss	UPM Silk	Cocoon Silk	Cyclus Print
Cyan	5.6	5.1	6.3	4.9	5.0
Magenta	5.7	4.6	5.5	3.8	5.9
Yellow	6.0	3.3	4.2	2.2	4.6
Black	2.8	1.5	4.4	4.4	8.2
Red	5.4	6.4	5.7	5.8	9.3
Green	8.2	8.2	7.7	7.5	10.6
Blue	10.2	10.6	8.9	9.1	13.2

Trapping. The measured values of trapping are in table 4. They are very similar for tested papers. In literature we can find values for trapping: C + Y – 85 %, C + M – 68 % and M + Y – 75 %. The differences between these values and measured ones are only for M + Y (5 – 15 %).

Table 4: Trapping values of overprints in [%]

	UPM Gloss	Cocoon Gloss	UPM Silk	Cocoon Silk	Cyclus Print
M + Y	66.8	64.8	69.4	70.0	69.2
C + Y	80.8	80.0	86.6	84.0	85.8
C + M	68.8	68.6	73.8	71.6	73.0

Grey balance. Grey balance was evaluated as colour differences between overprint CYM patches and equivalent K (black) patches. The results of measurement of grey balance colour differences are in table 5. Grey balance colour differences for four of the five test papers are at the same level, except of Cocoon Gloss. The differences in colour increase with the degree of coverage percentage.

Table 5: Colour differences ΔE_{ab} between CMY grey balance patches and equivalent K patches

	UPM Gloss	Cocoon Gloss	UPM Silk	Cocoon Silk	Cyclus Print
27%	3.8	2.7	3.5	3.2	3.3
53%	5.9	3.9	5.7	5.2	5.3
76%	7.3	5.4	7.8	7.3	7.6

Dot gain. Dot gain values were calculated for all tested paper and inks in the interval of tonal values from 5 to 95 %. In table 5 are presented dot gain values only for 50 %. As can be seen, all dot gain values are in accordance with the ISO standard, except values for black for UPM Gloss and Cyclus Print. Dot gain values for 80 % were at lower limit of tolerance interval.

Table 6: Dot gain values in [%] for tonal value 50 % and screen ruling 60 lpc

	Cyan	Magenta	Yellow	Black
UPM Gloss	13.6	13.4	15.6	12.8
Cocoon Gloss	14.6	14.3	16.2	16.8
UPM Silk	14.1	13.4	16.6	14.2
Cocoon Silk	12.8	12.8	14.9	14.2
Cyclus Print	13.8	13.4	15.8	12.8
ISO 122647-2:2004 P 1 a 2	10-14-18	10-14-18	10-14-18	13-17-21

CIE L*a*b* values of all tested papers fall into one category – wood-free coated according to ISO 12647-2:2004 (L* = 92– 93, a* = 0, b* = –3) within allowed tolerances. The dimensional stability of all papers during printing, evaluated by differences in the image positioning of printed colours, was not lager than 0.08 mm.

Conclusion

On the basis of the results obtained in this study, measured and calculated parameters of print quality, we can say that the printability of papers Cocoon Gloss, Cocoon Silk and Cyclus Print, made from 100 % recycled paper fibres, are the same as for standard wood-free papers UMP Gloss and UPM Silk.

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