Comparison of Print Characteristics of Wide Format Photograde Ink Jet Papers

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Abstract

Ink jet technology is used very often for indoor poster applications. Many different printing systems based on thermal or piezo ink jet printing are used, mostly with dye-based ink sets. A big variety of ink jet media is offered. It is often claimed that these media are universal for all combinations of inks and printers (thermal and piezo ink jet).

In this paper is presented a study of commercial photograde papers for wide format (WF) poster printing on 4 typical WF printers (2 thermal and 2 piezo ink jet printers). These media claim to be universal, i.e. they deliver photograde quality on both thermal and piezo ink jet printers.

Introduction

Wide Format poster printing is a strongly growing ink jet application. This market used to be dominated by thermal WF ink jet printers, but piezo WF printers have been available now for some years. The photograde media that show good quality on the thermal printers are mostly delivering poor results on the piezo printers. Dedicated piezo photograde media were launched on the market.

In many cases however both thermal and piezo WF printers are located at the same production site. This leads to the customers' demand that the photograde media should be used on both ink jet technologies, so-called universal media.

Several companies claim to deliver universal photograde media. In this paper is presented a study of these media on 4 WF printers. Printing characteristics concerning image quality and physical properties are reported.

The label of photograde media is used for several different types of media. The studied media were limited to cast-coated papers (CCP) and media based on RC-papers with ink-receiving layers coated on top. Here we consider two types: the RCPB-type (RC-paper with polymer blend receiving layer) and the RCPOR-type (RC-paper with porous ink-receiving layer). The RCPOR-type has been already for some time on the market for SOHO-printing. Recently a dedicated WF photograde RCPOR-type became available. The SOHO RCPOR-type media are universally printable, this is also claimed for the new WF material.

The goal of this study is to compare the universality of these three media types.

Experimental

Printing Specifications

ENCAD 700 with Encad GX inks. Thermal ink jet printer with 4 dye inks (CMYK); print resolution is 600 x 600 dpi. HP2500 with HP dye inks. Thermal ink jet printer with 4 dye inks (CMYK); print resolution is 600 x 600 dpi.

AgfaJet Sherpa 43 with AgfaJet dye inks. Piezo ink jet printer with 6 dye inks (CMYKLcLm); print resolution is 720 x 720 dpi.

Epson Pro 9000 with Epson Inks. Piezo ink jet printer with 6 dye inks (CMYKLcLm); print resolution is 720 x 720 dpi.

Printing Mode. For all 4 printers the print mode is a photographic mode for the best quality possible. ONYX PosterShop 5.0 RIP is used on all 4 printers.

Ink Jet Media

Cast-coated Papers (CCP).

For this study two cast-coated papers (no. 1 and no. 2) were selected because they belong to the best of the CCP-type. They claim to be universally printable.

RC- Paper Polymer Blend (RCPB).

Recently four ink jet media of the RCPB-type were introduced. It is claimed that they deliver universal print quality. These are the papers nos. 3 – 6.

RC-Paper Porous Layer (RCPOR).

A recently introduced ink jet paper of the RCPOR-type (no. 7) is claimed to be universally printable on WF thermal and piezo printers.

Reference Media for Specific Photograde Media of the RCPB-Type. RM1 is the reference quality for thermal printers; RM2 is the reference quality for piezo printers.

Methodology Test Procedures

Printing of Test Files. All test files are printed without ink limitation.

Image quality is judged on a print with patches that show bleeding, coalescence, etc. This is used together with the ONYX ink limit swatch to find the maximum ink limit that is free of image defects.

Drying Times. Several rows of patches of 100 – 200 and 300% ink are printed and with different time intervals the smearing out of the ink is tested.

Water Fastness. Prints of patches of single color 100% ink amounts are completely dried and then dipped into water of room temperature during 1 minute.

Color Gamut. A simplified calculation method is used to get an idea of the color gamut. CieL*a*b*-values of more than hundred patches are measured. These values are used to calculate the color space, so to compare the different media.

Reports of the Results

The image quality and physical properties (drying, water fastness, waving) are studied in detail for each media/printer combination. The results are summarized in tables 1 – 4.

The image quality aspect is expressed as the maximum ink amount that can be printed (ink limit) before an image quality problem occurs. In the tables all the observed defects are mentioned (remark). The defects are indicated by a caption. See caption survey below.

The physical properties evaluation is expressed as a global evaluation varying from very good (++) over acceptable (0) to very poor (--). The problem is also indicated by a caption. See caption survey below.

Caption Survey

B	bleeding
BR	bronzing
C	coalescence
CO	color output
DR	drying time
DM	drying marks
F	feathering
IC	image cockling
M	matting
OF	overflow of ink
S	prints stay sticky
TQ	text quality
W	waving (=cockling)
WF	water fastness

Results for ENCAD 700

Table 1 gives the overview of the results on the thermal ink jet printer ENCAD 700 with Encad GX dye inks.

The cast-coated papers nos. 1 & 2 both show a strong bleeding defect, limiting the maximum ink load to around 200%. The waving problem is severe and consists of both imagewise and overall cockling. Text quality is poor. The color output problem (CO) which is observed is that the CMY patch is much lower in density than the K patch; this is not the case for the other media.

Table 1. Results on Encad 700

PAPER TYPE		IMAGE QUALITY			PHYSIC. PROP.
		Ink limit	Problem	Remark	
CCP	no. 1	200%	W,B	W,B,CO TQ	+ W
	no. 2	180%	W,B	W,B,CO TQ	+ W
RCPB	no. 3	300%	DM	DM	- DR WF
	no. 4	350%	M	M	0 WF
	no. 5	300%	M	M,IC	0 WF
	no. 6	350%	M	M	0 WF
RC POR	no. 7	190%	DM,B	DM,BR B,OF	- DR

The RCPB-type media nos. 3 – 6 show generally a good image quality. There are no problems of bleeding or coalescence. The problems that occur are related to print gloss. Matting and/or drying marks are observed. This is always above 300% ink load.

The RCPOR-type paper no. 7 is limited in ink amount by the occurrence of drying marks and bleeding. It is observed that the maximum ink amount that can be absorbed is limited to 300% ink. Putting more ink on this paper leads to running off of this extra ink over the print (called overflow of ink, caption OF). Also bronzing is noticed.

The drying time and water fastness are very good for the CCP-type papers. The RCPB-types show a very poor water fastness and the drying times are in the range of 10 to 20 minutes. Also the paper no. 7 needs 20 minutes drying time before no ink can be smeared out.

Results for HP 2500

Table 2 shows the results on the thermal ink jet printer HP2500 with HP dye inks.

The ink amount for the CCP-type papers nos. 1 & 2 is limited by the waving (cockling) defect. Bleeding is also observed, but at high ink loads (300% for no.1 and 350% for no. 2). Again the color output problem is observed (density of CMY much too low).

The RCPB-type paper no. 5 shows severe matting while nos. 4 & 6 show matting at 300% ink. Paper nos. 3 & 5 show drying marks.

The RCPOR-type no. 7 is limited in ink amount by coalescence at 250%. Overflow of ink again occurs from 300% ink and higher. Drying marks and bleeding are also observed.

The physical properties are very similar to the results for the Encad printer. Drying times for the RCPB-types are 10 – 20 minutes. The drying time for the RCPOR-paper is fast on HP2500, while it amounts to 20 minutes on Encad.

Table 2. Results on HP2500

PAPER TYPE		IMAGE QUALITY			PHYSIC. PROP.
		Ink limit	Problem	Remark	
CCP	No. 1	270%	W	W,B,CO	+ W
	No. 2	270%	W	W,B,CO	+ W
RCPB	No. 3	220%	DM	DM,M	- DR WF
	No. 4	300%	M	M	0 WF
	No. 5	200%	M	DM,M	0 WF
	No. 6	320%	M	M	0 WF
RC POR	No. 7	250%	C	C,B,DM OF	++

Table 3. Results on AgfaJet Sherpa 43

PAPER TYPE		IMAGE QUALITY			PHYSIC. PROP.
		Ink limit	Problem	remark	
CCP	no. 1	250%	W	W,CO TQ	+ W
	no. 2	250%	B,W	W,CO TQ	+ W
RCPB	no. 3	80%	C	C,DM	0 WF
	no. 4	100%	C	C,B	0 WF
	no. 5	100%	C	C	-- DR WF
	no. 6	100%	C	C,B,DM	-- DR WF
RC POR	no. 7	160%	C	C,F,BR OF	+

Results on AgfaJet Sherpa 43

Table 3 shows the results on AgfaJet Sherpa 43 piezo printer with AgfaJet dye inks.

The CCP-papers suffer from waving from 250% ink load on and suffer also from bleeding (no. 1 from 300% ink and no. 2 from 250% ink). The color output problem is again visible (low density for CMY). Text quality is poor.

The RCPB-type media are very poor in image quality. Papers nos. 3 – 6 all show strong coalescence. Papers no. 4 & 6 show bleeding. Papers nos. 3 & 6 also show drying marks. The ink limit is very low due to the coalescence.

The RCPOR-type no. 7 has also a low ink limit of 160% because of coalescence. Overflow of ink is again observed at 300% ink load (also for Encad and HP printers). Bronzing is noticed.

The physical properties of the CCP-papers are again very good (instant dry and good water fastness), but waving is a big problem. The RCPB-type media nos. 3 & 4 are drying rather fast, while nos. 5 & 6 need more than 20 minutes. Water fastness is poor. The RCPOR-type no. 7 is dry in 10 – 15 minutes and water fast.

Results on Epson Pro 9000

Table 4 shows the results on Epson Pro 9000 piezo ink jet printer with Epson dye inks.

Table 4. Results on Epson Pro 9000

PAPER TYPE		IMAGE QUALITY			PHYSIC. PROP.
		Ink limit	Problem	Remark	
CCP	no. 1	180%	B,W	W,B,CO TQ	+ W
	no. 2	150%	B,W	W,B,CO TQ,F	+ W
RCPB	no. 3	100%	C,DM	C,DM,S	-- DR S
	no. 4	100%	C,DM	C,DM,S TQ	-- DR S
	no. 5	100%	C,DM	C,DM,S	-- DR S
	no. 6	100%	C,DM	C,DM,S BR	-- DR S
RC POR	no. 7	160%	C	C,B,DM TQ,F OF	+/++

The CCP-papers show strong bleeding and waving, starting at 180% ink load. Also the problems of color output and text quality are observed.

The RCPB-type media all show very strong coalescence from 100% ink load on. Strong drying marks occur. The prints stay sticky for a very long time (weeks).

The RCPOR-paper no. 7 shows strong coalescence, starting at 160% ink. Also bleeding, drying marks, low text quality and overflow of ink (starting at 200% ink) are observed.

The CCP-papers and the paper no. 7 have very good physical properties, except the waving of paper nos. 1 & 2. The RCPB-type media need much more than 20 minutes to dry and stay sticky for a very long time, giving very strong ink transfer from one print to the back of the next print or in an automatic take-up printing mode.

Color Output Experiment

The difference in color output for cast-coated papers compared to that of the RCPB-type media was studied in more detail for one printer, Agfajet Sherpa 43. The observation that the CMY patch is low in density and differs strongly from the K patch indicates a color gamut problem.

Table 5. Comparison of Color Gamut for AgfaJet Sherpa

Paper type	Color space Calculation	L* minimum
no. 1	460.000	8
no. 2	410.000	11
no. 3 – 7	600.000 – 650.000	1

The CCP-type papers nos. 1 & 2 have a significantly lower color gamut than the RCPB-type media nos. 3 – 7. Not only the color space is much smaller, but also the lowest L*- value possible is much higher. This means that the degree of color saturation is much lower.

General Overview

The comparison of the photograde media is summarized in table 7 for all 4 printers.

The evaluation of the media RM1 and RM2 is added as the reference quality level of the specific thermal and piezo photograde media.

Table 7. General Comparison For All 4 Printers

PAPER TYPE		ENCAD 700 GX		HP 2500		AgfaJet Sherpa 43		Epson 9000	
		IQ	PP	IQ	PP	IQ	PP	IQ	PP
CCP	no. 1	0	+	0/+	+	0	+	--	+
	no. 2	--	+	0/+	+	0	+	--	+
RCPB	no. 3	+	-	0	-	--	0	--	--
	no. 4	++	0	+	0	--	0	--	--
	no. 5	+	0	+	0	--	--	--	--
	no. 6	++	0	++	0	--	--	--	--
RC POR	no. 7	-	-	0/+	++	--	+	--	+
RM1		++	0	++	0/+				
RM2						++	0/+	++	0

IQ = image quality PP = physical properties

Discussion

Table 7 shows a clear picture of the printing characteristics of the studied photograde media.

The cast-coated papers (CCP) are limited in their photograde image quality. The color gamut is strongly limited; especially high saturation of the colors is critical. This can be explained by its nature: the material can be considered as an overall porous paper that absorbs ink, resulting in deep penetration of the ink. The image quality is at the minimum acceptable level. An important limitation of the ink amount is necessary. This limitation is also necessary to avoid the strong waving (cockling) of the printed cast-coated paper. This can lead to touching of the printheads and it is also a strongly negative cosmetic issue.

The advantages of the cast-coated papers are the very short drying times and the high water fastness. The CCP-type papers thus can be used for less critical applications.

The RC-paper based media have a support that is non-absorbing. The ink is only absorbed in the image-receiving layer(s). The RCPOR-type (no. 7) has layers of a porous nature (pigment/binder system). The RCPOR-type media for SOHO-applications deliver universal print quality and good physical properties (instant dry and water fast) on NF ink jet printers. Paper no. 7 does not deliver this high quality level for WF printing. The amount of ink that can be absorbed is limited too much. This results in image defects like bleeding and coalescence, and at some point it leads to an "overflow" of ink that is not absorbed anymore and runs out over the image. This happens at 300% ink load for most of the printers (at 200% for Epson 9000).

The RCPB-type media nos. 3 – 6 are either not universal concerning image quality. The print quality on thermal printers is mostly good to very good, but very poor on the piezo printers. This is in contrast with the specific photograde piezo papers (like RM2) that show a very good image quality on these piezo printers. So the print quality is thus not universal at all. Drying time is critical and water fastness is usually very poor. The nature of the polymer blend is very important for the print quality. Different kinds of polymer blends seem to be needed for piezo versus thermal ink jet.

Conclusion

The use of photograde ink jet media for indoor poster applications was studied regarding the possibility of using one single photograde paper on different printers, thermal ink jet printers as well as piezo WF ink jet printers.

The photograde media of the cast-coated paper type deliver only a minimum acceptable quality level on 3 printers (severe bleeding on Epson 9000). The advantages of cast-coated papers are the instant drying and high water fastness. The biggest disadvantages are the strong cockling and the limited color output.

The tested photograde media of the RC-paper polymer blend type are not universal at all. The print quality is mostly O.K. on thermal printers. The print quality on the piezo printers is not acceptable at all. Drying time can be critical and water fastness is mostly very poor.

The tested photograde paper of the RC-paper porous layer type is limited too much in ink uptake; this needs to be improved to make this type practical for WF poster printing.

It can be concluded that the use of one single photograde paper on thermal and piezo ink jet printers for poster applications is still a compromise. The customer demand for high quality output on different printers is not yet fulfilled for one single photograde paper. It is better to use the dedicated piezo or thermal media to get the best quality.

Biography

Marc Graindourze got a Ph. D. at the K.U. Leuven, Belgium (physical chemistry). In 1988 he joined Agfa-Gevaert N.V., Belgium, where he started as a project manager R&D prepress materials. Since 1996 he is project manager R&D ink jet media. His focus is on photograde ink jet media for both narrow and wide format ink jet printing.