Comparison of Photograde Media for Wide Format Ink Jet Poster Printing

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Abstract

Ink Jet Wide Format poster printing keeps growing fast. Improvements in printers, inks and media continue to deliver higher quality at faster printing speeds.

This paper discusses the role of the photograde media towards the quality of the print. In particular, the difference between polymer blend type media and microporous type media is discussed. The newest media of both types are evaluated.

Introduction

The quality of ink jet Wide Format poster printing keeps improving. New developments in printers, inks and media are driving this progress.

Photograde media which are capable of delivering the expected quality are based upon non-porous supports (usually RC-paper) whereon (on one or both sides) one or more ink-receiving layers are coated.

In general, the ink-receiving layers can belong to two type of layers: polymer blend (swelling) type or microporous (ceramic, nanoporous,…) type.

The differences between both layer types were discussed on several NIP-conferences. On NIP17 a paper was presented about poster printing.[1] It was shown that the polymer blend type media could deliver good print quality, but only on a selection of printers. The polymer blend type media were dedicated thermal or piezo media and could not be used universally. On the other hand, the microporous type media could be used more universal (on all printer types), but were limited in the amount of ink uptake.

The goal of this paper is to present a study about the current situation for poster printing. Photograde media of both layer types (polymer blend and microporous) are printed on the newest printers (thermal and piezo printers).

In this paper the results are presented of print studies on the newest photograde media for poster applications on the newest Wide Format printers (thermal ink jet: HP5000 printer; piezo ink jet: Agfa Grand Sherpa printer). For both layer types (polymer blend and microporous) some results of experimental work are presented to help explain the findings in this study.

Experimental

Printing Specifications
HP5000 with HP dye and pigment inks. Thermal ink jet printer with 6 inks (CMYKLcLm).
Photograhic print mode: 600 x 600 dpi, 6 colors, multiple passes (10), bi-directional printing.
Agfa Grand Sherpa with AgfaJet dye- and pigment-inks.
Piezo ink jet printer with 8 ink cartridges (possibility to use 6 colors or 2 times 4 colors (fast speed) or 4 dye-based inks and 4 pigment-based inks).
Photographic print mode: 720 x 720 dpi, 6 colors (CMYKLmLc), multiple passes (4), bi-directional printing.

Ink Jet Media

Four media are tested. They all have a RC-paper support. They all have a glossy finish. Material No. 1 is a polymer blend type (AgfaJet). Material Nos. 2 – 4 are microporous media; material No. 2 is an AgfaJet material; Nos. 3 – 4 are from other manufacturers.

Methodology Test Procedures

Printing of Test Files. The first print is always an ink limit swatch without ink limitation to control the amount of ink uptake. Image quality is judged on test files (with and without ink limitation) that contain patches that show bleeding, coalescence, etc.

Drying Times. Several rows of patches of 100 – 200 – 300 % of ink are printed and with different time intervals the smearing out of the ink is tested. Also the possibility of unattended printing (automatic roll-up) is tested on critical patches with high ink loads.

Coating Experiments. Single pass coatings out of aqueous solutions with a cascade coating system.

Microscopic Evaluation. Cross-sections of 10 micron thickness of the non-printed and printed layers were made by means of microtomy. A Leica optical microscope with a digital camera was used for capturing the images.

Reports of the Results

The image quality and physical properties (drying, water fastness) were studied in detail for each media/printer combination. The tables only give a summary of the results. The tables give comparisons of the quality between the different materials. The observed problems are indicated by a caption. See caption survey below.

Caption Survey
Evaluation:

PQ	print quality
DR	drying time

Image Defects:

B	bleeding
C	coalescence
DM	drying marks
LD	low density
M	matting
MS	matt stains
S	prints stay sticky

Print Results

The print evaluations are performed with a photographic quality print mode. The summary of the most important quality aspects is presented in table 1 for HP5000 and in table 2 for Agfa Grand Sherpa.

Table 1. Print Results on HP5000

Material	Dye-based inks		Pigment-based inks	
	PQ	DR	PQ	DR
No. 1	++	+	--LD	--S
No. 2	++	++	+ (B,C)	+
No. 3	++ (C)	++	+ (B,C)	+
No. 3	++ (B,MS)	++	+ (B,C,MS)	+

Table 2. Print Results on Agfa Grand Sherpa

Material	Dye-based inks		Pigment-based inks	
	PQ	DR	PQ	DR
No. 1	++	+	- LD	-
No. 2	++	++	+ (M)	+
No. 3	++ (M)	++	In Progress	
No. 3	++ (M,MS)	++	In Progress	

Table 1 gives the results for the HP5000. For dye-based inks, the difference in quality between the media is rather limited. When limiting the amount of ink, all media perform pretty well. For the materials Nos. 3 and 4 it is absolutely necessary to lower the amount of ink, because of matting. Material No. 4 shows (on all printers) some matt stains when printed, becoming more and more hindering with higher ink loads. For pigment-based inks, the polymer blend material No. 1 is less suited, because of low density. The microporous materials Nos. 2 – 4 deliver good quality but the ink amount has to be limited more than for dye-based inks; the drying times are a bit longer, but still short.

Table 2 shows the results for the Grand Sherpa printer. Unfortunately, all the results for the pigment-based inks were not yet available. The results for the dye-based inks differ between the materials. The polymer blend type material No. 1 has no problem with accepting all the ink and shows no coalescence or bleeding; also the drying is very fast and very similar to the drying time of the microporous media. The microporous materials Nos. 2 – 4 are limited in ink-uptake. When the ink amount is limited, the print quality is real good for all three media. Drying time is extremely fast. For the pigment-based inks the results are only available for the first two materials. The polymer blend material No. 1 is not well suited (low density, slow drying). The microporous material No. 2 performs well with the pigment-based inks when the ink amount is limited; drying time is good.

The results are discussed more in detail in the next paragraphs. Some experimental results are discussed to further explain these results.

Polymer Blend Media

We first discuss the results for the polymer blend type media. The material No. 1 is a new material with improved polymer blend layers.

Dye-Based Inks

The big advantage of this material No. 1 is that it can be used on both thermal and piezo printers with dye-based inks. Not only the print quality is very good, but also the drying times are very acceptable: unattended printing is possible without any transfer of ink to the backside or sticking of the rolled up prints.

Pigment-Based Inks

The print quality with pigment-based inks on polymer blend type media is critical. The problems generally are lower print densities and smearing out of the ink during a long time after printing. This is also the case for material No. 1 printed with HP5000. The quality on Grand Sherpa is better: density is higher and less smearing out of the inks. Lowering of the ink amounts gives an improvement, but the quality stays rather low. This material is not recommended for printing with pigment-based inks.

Hybrid Polymer Blend

The material No. 1 is not an ordinary polymer blend type containing only mixtures of polymers. In fact, it is special in its layer arrangement. It contains two ink-receiving layers. The top layer is containing not only polymer(s), but also some amount of inorganic pigment; the bottom layer is essentially consisting of only polymers. This type of hybrid polymer blend delivers tremendous advantages towards both print quality and drying times. The print quality with dye-based inks is very high on both thermal and piezo printers. The drying time is also improved: short smearing times and O.K. for unattended printing. In the next paragraph some experiments with different layer arrangements are discussed to explain these effects.

Experimental Study On Hybrid Polymer Blends

Coating trials were performed to show the effect of the layer arrangement on print quality on thermal and piezo printers with dye-based inks. The main components of the layers are polymers A and B, and an inorganic pigment. Variations in the compositions of both layers were coated and evaluated for print quality and drying time on thermal and piezo printers.

Table 3. Description of Coating Experiments on Hybrid Polymer Blend Type

Experiment	Layer 1	Layer 2
Exp. 1	Polymer A	No top layer
Exp. 2	Polymer A	Polymer B
Exp. 3	Polymer A	Pigment/binder <1/1 50%-50% polymer A and B
Exp. 4	Polymer A	Pigment/binder >1/1 Binder = polymer B
Exp. 5	Polymer A	Pigment/binder <1/1 Binder = polymer B

Table 4. Print Results for the Polymer Blend Coatings

Experiment	Thermal Printers		Piezo Printers	
	PQ	DR	PQ	DR
Exp. 1	- B	--- S	--- C	--- S
Exp. 2	---B,M,BA	-- S	- C	-- S
Exp. 3	-- M	OK	- C,M,BA	OK
Exp. 4	--- B,M	OK	-B	OK
Exp. 4	OK	OK	OK	OK

The results in table 4 clearly demonstrate the need for a layer arrangement with a double layer of the following nature: polymer B and inorganic pigment in the top layer and polymer A in the bottom layer. The pigment is needed to improve drying time. The polymer A cannot be used in the top layer, because it gives serious printing problems (e.g. coalescence) with piezo printers.

Microporous Media

Now the results out of table 1 for the media of the microporous type (materials Nos. 2 – 4) are discussed.

Dye-based Inks

The drying times on both HP5000 and Agfa Grand Sherpa are extremely fast for all these materials.

Concerning the image quality, the difference on HP5000 is not so very large for the three media. Materials Nos. 2 and 3 show more coalescence than bleeding, material No. 4 shows stronger bleeding and less coalescence. The ink amount can be limited to avoid bleeding and coalescence; then the print quality is real good.

The image quality on the Grand Sherpa printer is more depending on the media type. Material No. 2 can take up most of the ink, while the two other media are limited in ink amount. Also the densities are lower for materials Nos. 3 and 4 and print gloss is lowered.

Pigment-based Inks

For the HP5000 with pigment-based inks the image quality is limited by the ink uptake for all three media. From 200 % ink on bleeding and coalescence lower the quality.

Limiting the ink amount is possible to deliver good print quality without bleeding or coalescence.

Drying times are slower than for dye-based inks, but are still fast. The most important feature is that the smearing of the inks is very limited after 15 minutes after printing.

For the Agfa Grand Sherpa printer only material No. 2 was evaluated (other in progress). Material No. 2 is drying fast (without smearing after 15 minutes) and the image quality is good with profiling (ink limitation).

Comparison of the Media

The difference in quality on HP5000 for both dye-based and pigment- based inks is rather small; all three media can be used. Print quality with dye-based inks is very high; with pigment-based inks the quality is good, although the amount of ink that can be absorbed is limited.

For the print results on Agfa Grand Sherpa we are limited to the dye-based inks. There is a clear difference between the three media. The amount of ink that is well absorbed diminishes in this order: No. 2 > No. 3 > No. 4. Materials Nos. 3 and 4 show lower densities of mixed colors, print matting, and non-uniformity of patches with high ink loads.

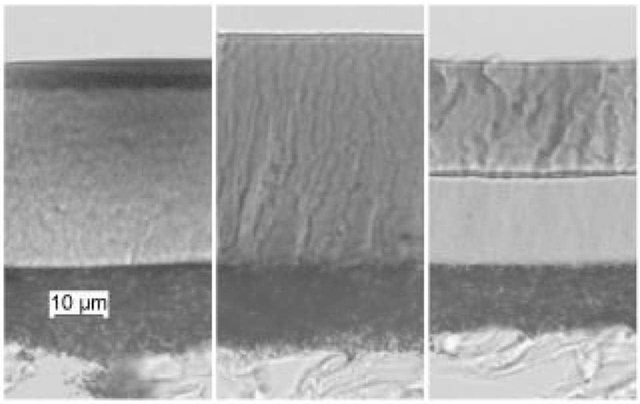
Microscopic Study of Ink Penetration

The difference in print quality for printing on Agfa Grand Sherpa with dye-based inks between the microporous media is studied more in detail. It seems that the three media react differently to higher ink amounts. The CMY-patch (100% of C + M + Y) was evaluated. Table 5 summarizes the results for the three microporous media.

Table 5. CMY Print Results

Material	Gloss	Uniformity	Remark
No. 2	Good	Good	High density, all ink accepted
No. 3	Lower	Poor	Low density, Some ink running out
No. 4	Non-Uniform	Poor	Medium density, Ink running out

It was suspected that these differences could be explained by the location of the CMY-dyes in the ink-receiving layers. Therefore, cross-sections of the printed CMY-patches were made and evaluated by optical microscopy. Figure 1 shows the cross-sections of the CMY-patches.



Mat. No. 2 Mat. No. 3 Mat. No. 4

Figure 1. Cross-sections of the CMY-patches.

In figure 1 the cross-sections of the CMY-patches are shown, with the dark area below being the pigmented Pelayer of the PE-paper support and on top the ink-receiving layer(s) filled with the CMY-dyes.

Figure 1 shows that the location of the CMY-inks is different in the three materials Nos. 2 – 4.

Unfortunately, the black and white copy of the colored cross-sections is less clear than the original. Therefore, the results are described here.

The cross-section of material No. 3 gives an overall bluish gray color, indicating that the three dyes are located all over the thick ink-receiving layer.

The cross-section of material No. 4 is pretty special. The cross-section clearly shows two distinct layers (also in the non-printed cross-section). The top half of the material is colored blue, followed by a rather thin magenta zone, and the bottom half part is green. The fixation of the three dyes seems to be totally different in the two receiving layers.

The cross-section of material No. 2 shows a dark deep blue/black area in the upper part of the material and a large light gray zone in the middle, and a light green zone at the bottom. It seems that a high concentration of all three dyes is located in the top of the material, and that only a limited amount of dye is concentrated in the lower layer parts.

The location of the dyes in the layer seems to be extremely important for the print quality in areas with high ink loads. The best situation seems to be the one where the dyes are located in the top area of the ink-receiving layer. Deep penetration of dye into the layers can lead to lower densities, especially when the layer is not transparent. The transparency of microporous layers is lowered by the presence of the inorganic pigments (usually white pigments). Deep penetration of ink in this type of layers is resulting in limited optical densities.

The fact that not all ink is accepted by the materials Nos. 3 and 4 cannot be explained by these cross-sections, but is most likely due to too low capillary capacity of the inkreceiving layer(s).

Discussion

This paper contains some interesting experiments on media design for photograde poster printing.

The two types of ink-receiving layers for photograde quality (polymer blend and microporous) are improved.

The results in this paper show that both polymer blend type media and microporous type media can be used for poster applications. The quality of both types is different.

The print quality and drying characteristics of these media types were discussed. Of course, these are not the only criteria to choose between these two layer types.

Other advantages of the polymer blend type media are the low cost of this layer type and the better image permanence (with dye-based inks) compared to the microporous type. On the other hand, the microporous type media have the advantages of being very universal (thermal and piezo, both with dye- and pigment-based inks) and high water fastness compared to the polymer blend type.

It is clear that poster printing is a general term for many applications which vary seriously in their demand for print quality, image permanence, cost price and other characteristics.

The image quality of both media types is very high and for practical jobs it is often very difficult to distinguish both types. Therefore the choice should be made in view of the customers' demands of overall quality (including cost price and image permanence).

The polymer blend type media were often limited because of two important drawbacks. The first one is that the print quality usually was only of a premium quality on a single printer type. The second one is that one has to take care with the drying of the inks. The drying could be too slow to allow unattended printing.

The new polymer blend type (hybrid polymer blend) is overcoming these problems. The print quality is very high for both thermal and piezo printers (with dye-based inks) and the drying times are improved so that unattended printing is possible. The cost price of the hybrid polymer blend is comparable to the normal polymer blend type media.

The microporous type media are based upon thick layers consisting of a high amount of pigment (inorganic) and a rather limited amount of binder. Compared to the polymer blend type media, this type of layer is more difficult to produce and the cost price of the ingredients is much higher. The image permanence (light, ozone fading) is reported to be much lower due to the open structure of this layer type. On the other hand, it is exactly this porous structure that enables the fast drying times. Also a very important advantage is the ability to produce good print results and fast drying times with pigment-based inks. The pigment-based inks keep improving for gloss and color gamut and have an advantage for image permanence. The combination of pigment-based inks and microporous type media is therefore being used more and more.

Conclusion

The use of photograde ink jet media for indoor poster applications was studied on the latest generation of ink jet Wide Format poster printers.

The two types of receiving layers, being polymer blend type and microporous type layers, are compared towards their use for poster printing.

The R&D effort on both layer types has resulted in photograde media that can be used for poster applications, whereby the choice can be made by the customer depending on the needs of the poster application.

The newest polymer blend type (hybrid polymer blend type) is suited for both thermal and piezo printers with dyebased inks. Image quality is very high and the drying times are short to very short and unattended printing is possible.

The microporous type media can be used with thermal and piezo printers with both dye- and pigment-based inks. The drying times are extremely short (the shortest for the dye-based inks). Image quality is very high. There still is a limitation in ink uptake. The location of the dyes of the dye-based inks in the microporous layer(s) was studied. It was shown that the location of the dyes strongly differs between different microporous receiving layers (as well as the amount of ink that can be absorbed).

References

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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 pre-press 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.