

WHITE PAPER ON SUBLIMATION TECHNOLOGIES

Rel. 1.6

- 1) So called "traditional procedure";
- 2) Direct printing on fabric and sublimation subsequent on separate calender;
- 3) Direct printing on fabric and sublimation subsequent in integrated system using hot air;
- 4) Direct printing on fabric and sublimation subsequent in integrated system with contact calender;

*Different
technologies for
the same purpose,
which is the best?*

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Sublimation

(Phase Transition)

http://en.wikipedia.org/wiki/Sublimation_%28phase_transition%29

Using so-called "sublimatic inks", inks that once deposited on media (in most o cases paper), if taken at high temperatures (200° C) "sublimate" pass from solid to gaseous state without passing through the intermediate liquid state. A good analogy might describe this behavior as "an explosion of the ink".

The procedure of transferring ink from the paper to the final media (polyester) requires use of a calender or a press, with the objective of bringing the average polyester to a temperature where the polyester fibers become soft and supple allowing the ink (transformed into gas) to penetrate, thanks to the pressure of the press.

When the fiber cools down the pigment of dye is incorporated within the fiber.

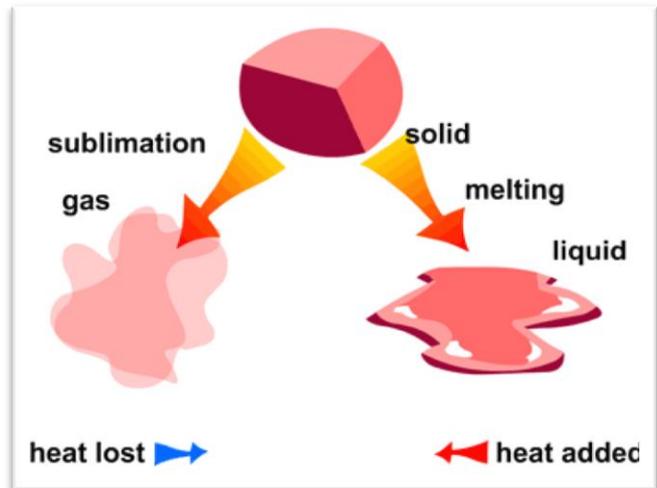
In practice, instead of simply coloring the

surface of polyester fiber (as in case when using solvent or UV inks) it gets the color inside the media.

The process requires a high chemical affinity between dye and polyester fiber and vice versa because otherwise there would be a lack of penetration, this explains why you can't use sublimatic inks for printing on other textile fibers, like cotton wool or silk.

You can get some other tips on sublimation from:

<http://www.sawgrassink.com/education-events/sublimation-knowledgebase>



Inks, Need to know one, washing ?

The sublimation process works because there is an high chemical affinity between the polyester media and the ink but it could be that there is a limit on the amount of ink that can be "accepted" by the media.

In this perspective the sublimation process it is like an airplane with 200 seats, you can "allocate" 200 people but not more, the excess will be in "overbooking" that in our technology means that it will be not fixed on the media and it will stay "on-the-air", it will be stick on the protective paper, it can stay on the media or it will stick on various part of the printer/calender.

This is a chemical/physical limitation, it cannot be overcome in any way.

All the direct printed fabric with whatever technology it has been printed:, screenprint, rotary, digitally, should be washed if the final use can create problems of bleeding because you can

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never been sure that all the inks on the media has been fixed, that's why a washing it is always advisable, it is possible to reduce the risk at a minimum if strong controlling it is apply to:

- 1) Profile with less ink as possible to increase the chance that the most of it is fixed;
- 2) Good fixation at the highest temperature that the media can handle and probably we have the best system in this market as for fixation power (can you image the amount of ink that you can fix with simply hot air);
- 3) A media with a coating that help the fixation, some manufacture has a media that they claim that it does not need any wash;



If you are printing textile for kids bed you need to wash because even if the inks are EcoTex you have the risk that the kid is putting the textile in mouth and sucking it, as a consequence.. you need to wash;

If you are printing curtains that will be in contact with other polyester curtains, even without any water, there will be the chance that the ink migrate from the colored curtains to the white one, as a consequence ... you need to wash;

If you are printing chairs you can have the risk that if someone will sit on (what the chair has been invented for), even without water, there will be high chance that the ink can make dirty the

other textile, as a consequence ... you need to wash;

Inks, Need to know Two Sublimation/Disperse ?

Sublimation Ink? Disperse Ink? What are the differences?

Chemically Sublimation Ink is a "variation" of the disperse ink, the "variation" is related to the dimension of the molecule. Sublimation ink molecules are very small in order for it to sublimate (explode) turning into gas.

Sublimation Inks are the most common in the digital printing, very few manufacturers are producing "real disperse ink".

<http://www.digitaloutput.net/content/ContentCT.asp?P=2632>

Property of the Sublimation Inks (Low Energy Disperse dye):¹

- a) Common product, most ink manufacturers have them in catalogue
- b) Brilliant color;

¹ Typical Sublimation Ink Manufacturers

Sawgrass ®: <http://www.sawgrassink.com/>

Kiiian ®: <http://www.kiiian.com/>

J-Teck 3 ®: <http://www.j-teck3.it/eng/pages/home.php>

Sensient ®: <http://www.sensient-tech.com/solutions/inks.htm>

Dupont ®: http://origin.dupont.com/Artistri/en_US/index.html

InkTech ®: <http://www.inktec.com/english/>

- c) Weak color fastness, light, rubbing
- d) Easy printability
- e) The sublimation process and related Inks is/was a patent of Sawgrass;
- f) No Wash needed

Property of Disperse Inks: (High Energy Disperse Dye):

- a) Strong color fastness, light, rubbing;
- b) Color less brilliant compare to sublimation;
- c) Not common inks;
- d) Printability is not easy particularly on Epson based printers, Mutoh, Roland, Mimaki, Epson;
- e) In most of the cases washing is needed;

See also:

<http://provostinkjet.com/resources/SDC%2B%2BInk%2BJetPretreatment%2B4th%2BDec%2B03.pdf>

http://fabricgraphicsmag.com/articles/0707_f2_water.html

http://en.wikipedia.org/wiki/Digital_textile_printing

http://fabricgraphicsmag.com/articles/0310_f2_matching.html



Inks, Need to know three, temperature and humidity ?

Water based inks are quite sensitive to the temperature and humidity of the room in which the printer it is installed and printing.

As a general rule the temperature should be in the range of 20-25°C and the relative humidity should be above 45%.

In you will print in condition different from the one mentioned above you can experience missing printing jets and other defects in the printing quality.

This is the theory of the sublimation process, if we move from theory to practice we will find 4 different "processes" for implementing it:

- 1) So called "traditional procedure";
- 2) Direct printing on fabric and sublimation subsequent on separate calender;
- 3) Direct printing on fabric and sublimation subsequent in integrated system using hot air;
- 4) Direct printing on fabric and sublimation subsequent in integrated system with contact calender;

We will examine each one of these systems in the following pages.

Traditional Procedure²

Printing on transfer paper (do not forget that you have to print in mirror mode ☺), transfer on polyester using calender or heat press, the temperature must be set around 200° C, the time from 30 to 60 seconds.



Advantages

- 1) Printing on paper - you can virtually use any commercially available plotters that can print with sublimation inks (water based inks). You must be particularly careful before rewinding because the paper and inks must be perfectly dry to prevent marking and replication. When printing at high print speeds, it is difficult to achieve perfect drying before rewinding because with more speed you have less time to dry. In a production plant dedicated to sublimation it is quite common to see lots of fans in front of the rewinding paper to speed the drying process;
- 2) With careful management of profiles you can get details very sharp and very "dry" lines;
- 3) Generally standard polyester can be used without having to buy fabric that has been specially treated for direct digital printing;
- 4) A single big calender can generally handle more plotters, Calenders of good quality can transfer at high speeds (depends on the time of contact, which is generally between 30 and 60 seconds) even 100 or 200 meters per hour. It is obvious that if you use plotter printing at 30 sqm/h a single calender can support 3 plotters allowing the investment of calender to be shared across several plotters. This rule is valid only when using a plotter with "slow" print speeds. When printing at 70/80/100 sqm/h this speed is very close to the that of the calender;
- 5) This technology is used primarily for the sportswear market. After printing it is much easier to cut the printer paper than to cut the fabric on printer. Direct printing can offer

² Typical Calender Manufacture:

Monti Antonio ®: <http://www.montiantonio.com/index.php>

Klieverik ®: <http://www.klieverik.com/companyprofile.html>

Transmatic ®: <http://www.transmatic.it/>

Typical Plotter Manufacture:

Roland ®: http://www.rolanddg.com/ir_e/index.html

Mimaki ®: <http://eng.mimaki.co.jp/>

Mutoh: ® <http://www.mutoh-hd.co.jp/en/>

ATPCOLOR: ® <http://www.atpcolor.com/>

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a better penetration of ink in the media but the benefit cannot overcome the difficulties of the subsequent cutting;

- 6) You do not need to wash the final output (if it has been properly fixed);



Disadvantages

- 1) It is necessary to buy a press or a separate calender;
- 2) It is essential to purchase the paper for the transfer, and also the protective paper (see point 10);
- 3) When the ink is sublimated as a gas it cannot ensure sufficient penetration when you want to print on media that require a high "see-through" such as that required for the printing of flags;
- 4) You need additional space for the press or for the calender. Those systems are quite large especially when the format it is 2,6mt or 3,2 mt;
- 5) Calenders have a very high power consumption, 16KW or even 32kw/64Kw with very high power consumption and dedicated power lines;
- 6) Some Calenders require at least 60/120 minutes before being operational, others 60/120 minutes are require for cooling down, as a consequence you must have the calender (and the power consumption) on for all day even if you will not use it intensively;
- 7) The "process of transfer" can be quite tricky, especially on large formats and may require dedicated staff, in the 3, 20 mt it is quite common to see 5 people around the machine when the media is going to be loaded. You must manage, during the loading:
a) the printed paper; b) the polyester where to transfer the print; c) protective paper to protect the drum/felt and every media MUST be loaded perfectly even and without any shrinkage;
- 8) The transfer paper itself, in high format (particularly the 3,2mt) is much more expensive than the transfer paper for small format.
- 9) To protect the felt of the calender you should always use an additional sheet of very thin paper called "protective paper" (10 gr/sqm) to protect the felt in the calender from possible ink transfer;
- 10) You have to dispose both the transfer and the protective paper after the process;
- 11) The replacement of the felt is complicated and very expensive;



Risks during the printing phase/fixation

- 1) When transferring the ink, gaseous "bubbles" can be formed between the paper and the media that affect the quality of the transfer. This is especially a problem when the printing/paper format is quite large such as 2.6 mt or 3.2 mt;



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- 2) If the paper it is rewound when the inks are not completely dry the ink will stick or "migrate" from colored to white parts of the paper creating ghosting or replications on the white parts. This phenomenon may be more evident if the paper it is not immediately sublimated;
- 3) If the image we are going to transfer has some black (or highly colored area) beside some white area it is quite common that when the calender or the press is going to open, the gas created and not fixed in the polyester will escape creating a shadow or smoke effect;
- 4) The typical problem is that during the transfer process the polyester shrinks due to the high temperature while the paper does not. As a consequence it is quite common to have ghosting images: <http://www.sawgrassink.com/v.php?pg=161>

Direct printing on fabric, sublimation in separate calender³



Advantages

- 1) Direct printing on fabric guarantees beyond any possible doubt better penetration of the ink/pigment in textile substrate so that printing on media like flag can achieve a high see-through effect, You are putting the ink directly on the substrate and you are not transferring it with sublimation;
- 2) Transfer paper is not needed for sublimation;
- 3) A single big calender can generally handle more plotters, Calenders of good quality can transfer at high speeds (depending on the time of contact, which is generally between 30 and 60 seconds) even 100 or 200 meters per hour. It is obvious that if you use plotter printing at 30 sqm/h a single calender can support 3 plotters allowing the investment in the calender to be shared across several plotters. This rule is valid only when using a plotter with "slow" print speeds, when printing to 70/80/100 sqm/h this speed is very close to that of the calender;



Disadvantages

Disadvantages

- 1) Because we are no longer printing on paper, instead we are printing directly onto the fabric, it is necessary to use a plotter that has been designed and engineered to print directly on fabric. Because fabric does not have the same characteristics and dimensional stability as paper, a more advanced feeding system is necessary. Although you may find commercially available plotters that have had various systems added and modifications made to accomplish this, what is most important is being able to have precise control of advancement of the fabric. Without control of media feeding speeds, acceleration ramps, etc, the phenomenon of "banding" can occur on some or all media.
- 2) In most cases it is not possible to use a simple polyester because the ink will migrate on polyester fibers, so that it is necessary to use fabric that has been prepared for digital printing;

³ Typical Plotter Manufacture

Durst ®: <http://www.durst-online.com/>

Efi-Vutek:® <http://w3.efi.com/Vutek>

ATPCOLOR ®: <http://www.atpcolor.com/>

Hollanders ®: <http://www.hollanders-ps.nl/>

Mimaki ®: <http://eng.mimaki.co.jp/>

- 3) Depending on the printer engineering you could waste meters of fabric before you can start printing and meters wasted at the end of the printing, take this into consideration;
- 4) It is necessary to buy a press or a separate calender;
- 5) The print job is necessarily divided into two distinct phases, print and transfer with different expertise required;
- 6) You need additional space for the press or for the calender, those system are quite large especially when the format is 2,6mt or 3,2 mt;
- 7) Some Calenders require at least 60/120 minutes before being operational, others 60/120 minutes are require for cooling down, as a consequence you must have the calender (and the power consumption) on for all day even if you will not use it intensively;
- 8) The cost of a plotter designed for direct printing on fabric is greater than a plotter to print on paper, vinyl;
- 9) To protect the felt of the calender you should always use an additional sheet of very thin paper called "protective paper" to protect the felt in the calender from possible stains. Sometimes when the ink coverage is high or when using media with an open weave such as mesh flag, two protective sheets might be needed needed, one for the calender felt and one for the calender itself;
- 10) You have to dispose the protective paper after the process;
- 11) The replacement of the felt of the calender is complicated and very expensive.



Risks during the printing phase/fixation

- 1) When the fabric is rewound and the inks are not completely dry (and some printers do not have a dryer) the ink will stick or "migrate" from colored to white parts creating ghosting or replicas on the white parts. The phenomenon can be avoided by stopping the migration drying the media (and the inks) at a temperature of around 120°C only a few commercial systems provide for this possibility. This phenomenon may be more evident if the paper it is not immediately sublimated;
- 2) If the fabric feeding system is not carefully designed contact may occur between the head and the fabric or the advancement of the fabric is not consistent;
- 3) If the fabric feeding system is not specifically designed for the fabric but is a quick and easy modification of a paper feeding system, you can have a printout that has a length of 200cm, the same one printed after it will be 205cm and again the same it can be of 197cm, this happen when every step of the media is not constant and does not take into account the difficulties of the media;
- 4) Depending on the inks used it can be that you need to wash the output, in this perspective it is very important NOT to use standard sublimation inks (the ones used in the "traditional process") because those inks have a brownish carrier that will stay on the media surface and will be NOT fixed. When some water goes onto the media you will have black/brownish stain of ink. It will be a disaster when you have a colored area beside white ones. This will not happen if you will use inks dedicated to the direct printing because the carrier is transparent. IF you will have a colored stain it means that the fixation has not been good enough;

Direct printing on fabric and sublimation with hot air⁴



Advantages

- 1) Direct printing on fabric guarantees beyond any possible doubt better penetration of the ink/pigment in textile substrate so that printing on media like flag can achieve a high see-through effect, you are putting the ink directly on the substrate and you are not transferring it with sublimation;
- 2) You do not use the transfer paper for sublimation and the protective paper;
- 3) The integrated print system is extremely flexible and easy to manage;
- 4) These systems are normally significantly compact;
- 5) When the format are particularly wide, 2,6mt or 3,3mt the cost of such a calender it is quite relevant, in some perspective it could be that with the cost of only the calender you can buy a complete integrated system printer and fixation unit;



Disadvantages

- 1) Because we are no longer printing on paper, instead we are printing directly onto the fabric, it is necessary to use a plotter that has been designed and engineered to print directly on fabric. Because fabric does not have the same characteristics and dimensional stability as paper, a more advanced feeding system is necessary. Although you may find commercially available plotters that have had various systems added and

⁴ Typical Plotter/System Manufacture:

DGen ®: <http://eng.dgen.com/>

Agfa ®:

http://www.agfagraphics.com/gs/global/en/internet/maings/products_solutions/all_products/jeti_3324_aquajet.jsp

Century Star ®r: <http://www.sycenturystar.com/>

Eurotech ®: <http://www.eurotechprinters.com/2011/>

modifications made to accomplish this, what is most important is being able to have precise control of advancement of the fabric. Without control of media feeding speeds, acceleration ramps, etc, the phenomenon of "banding" can occur on some or all media.

- 2) In most cases it is not possible to use a simple polyester because the ink will migrate on polyester fibers, so that it is necessary to use fabric that has been prepared for digital printing;
- 3) Depending on the printer engineering you could waste meters of fabric before you can start printing and meters wasted at the end of the printing, take this into consideration;
- 4) Each print system has its fixation unit but it is also true that it is generally a lot cheaper than a traditional calender;
- 5) Some manufacturers can offer an upgrade path, when a new plotter (more color or more speed) will be released they can swap one plotter with the other preserving the investment on the calender, otherwise this investment will have the life time of its related plotter;
- 6) The cost of a plotter designed for direct printing on fabric is greater than a plotter to print on paper, vinyl;



7) In most cases it is not possible to use a simple polyester "because the inks tend to migrate on polyester fibers, whereby it is necessary to use fabric that has been prepared for digital printing;

8) Low efficiency "energy hog", inside the oven you create lots of smoke, exploding ink, evaporating any fabric treatments, all these fumes should be extracted almost continuously making the air inside the oven cooling down and you have to continually generate new hot air;

9) It is necessary to carry out a periodic cleaning of the calender to remove any impurities that settled during the heat;

10) The amount of heat that you can transfer in the same time is much lower

compared to a contact system (in physics it is called enthalpy <http://en.wikipedia.org/wiki/Enthalpy>). For an empirical explanation, you can heat to 200°C the oven in your kitchen, if you are fast enough you can put your hand in and out the oven without being burned, but in the unlucky event that your hand touches the oven walls (even for a fraction of a second) you will immediately feel the consequence "on your skin", this is the difference of enthalpy between a "contact" heating and a "non-contact" heating.



Risks during the printing phase/fixation

- 1) Heat without direct contact (convection/conduction) between ink/media is hardly controllable which may lead to uneven sublimation, some areas will be well sublimated, others areas will not;
- 2) When the ink in its gaseous state is not pressured or forced in any way to be in contact with the media those gases may create defects "smoking effect" especially between colored area and white ones;

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- 3) In order to avoid the problems referred in point 2) is possible to use disperse inks instead of sublimation (they will not turn into gas) but generally they have colors that are not bright;
- 4) In order to avoid the problems referred in point 2) some manufacturers build up systems to circulate the air inside of the "oven" (also because the warm air tends to go upwards creating different temperature zones), but the movement of air can lead to contact between the different layers of fabric inside with even more disastrous consequences;
- 5) Not perfect sublimation particularly on heavy media:
<http://www.bergertextil.com/assets/Uploads/Berger-DyeSub-direct-printing-on-heavy-fabrics04-2011.pdf>
- 6) Contact between the printed fabric and the cylinder inside the oven often creates ghosting images, this defect it is quite tricky because it shows up only after few week of printer running, too late to complain;
- 7) If the feeding system of the fabric is not specifically designed for the fabric but it is a quick and easy modification of the paper feeding system you can have a printout that has a length of 200cm, the same one printed after it will be 205cm and again the same it can be of 197cm, this happen when every step of the media is not constant and does not take into account the difficulties of the media;
- 8) Depending on the inks used it can be that you need to wash the output, in this perspective it is very important NOT to use standard sublimation inks (the ones used in the "traditional process") because those inks have a brownish carrier that will stay on the media surface and will be NOT fixed, When some water goes onto the media you will have black/brownish stain of ink, It will be a disaster when you will have colored area beside white ones. This will not happen if you will use inks dedicated to the direct printing because the carrier it is transparent. IF you have a colored stain it means that the fixation has not been good enough.

Direct printing on fabric and sublimation, with contact calender⁵



Advantages



1) Direct printing on fabric guarantees beyond any possible doubt better penetration of the ink/pigment in textile substrate so that printing on media like flag can achieve a high see-through effect, you are putting the ink directly on the substrate and you are not transferring it with sublimation;

2) You do not use the transfer paper for sublimation and the protective paper;

3) The integrated print system is extremely flexible and easy to manage;

4) These systems are normally significantly compact;

5) Very high enthalpy

<http://en.wikipedia.org/wiki/Enthalpy>, i.e. the system is very efficient, in other words it

produces a very good and even color fixation with vibrant color;

6) It is the only system that can combine the benefit of the direct printing and the experience of the calender transferring;

7) When the format are particularly wide, 2,6mt or 3,3mt the cost of such a calender it is quite relevant, in some perspective it could be that with the cost of only the calender you can buy a complete integrated system printer and fixation unit;



Disadvantages

1) Because we are no longer printing on paper, instead we are printing directly onto the fabric, it is necessary to use a plotter that has been designed and engineered to print directly on fabric. Because fabric does not have the same characteristics and

⁵ Typical Plotter Manufacture

ATPColor[®] : www.atpcolor.com

dimensional stability as paper, a more advanced feeding system is necessary. Although you may find commercially available plotters that have had various systems added and modifications made to accomplish this, what is most important is being able to have precise control of advancement of the fabric. Without control of media feeding speeds, acceleration ramps, etc, the phenomenon of "banding" can occur on some or all media.

- 2) In most cases it is not possible to use a simple polyester because the ink will migrate on polyester fibers, so that it is necessary to use fabric that has been prepared for digital printing;
- 3) Depending on the printer engineering you could waste meters of fabric before you can start printing and meters wasted at the end of the printing, take this into consideration;
- 4) Each print system has its fixation unit but is generally cheaper than a single calender;
- 5) Some manufacture can offer an upgrade path, when a new plotter (more color or more speed) will be released they can swap one plotter with the other preserving the investment on the calender, otherwise this investment will have the life time of its related plotter;
- 6) The cost of a plotter designed for direct printing on fabric is greater than a plotter to print on paper, vinyl;
- 7) It is necessary to carry out a periodic cleaning of the calender to remove any impurities that settled during the heat, unless the manufacture developed different solutions;



Risks during the printing phase/fixation

- 1) Here you have a contact between the media and the calender surface, this contact depends strictly on the designs of the system, you can have system with the contact on the printer surface, with thee contact on the rear surface or with both, the more flexibility you can have at this level the better it is, it can prevent ghosting and replica problems;
- 2) When the ink in its gaseous state is not pressured or forced in any way to be in contact with the media those gases may create defects "smoking effect" especially between colored area and white ones, this problem it is more visible when using sublimation inks instead of direct disperse;
- 3) If the feeding system of the fabric is not specifically designed for the fabric but it is a quick and easy modification of the paper feeding system you can have a printout that has a length of 200cm, the same one printed after it will be 205cm and again the same it can be of 197cm, this happen when every step of the media is not constant and does not take into account the difficulties of the media;
- 4) Depending on the inks used it can be that you need to wash the output, in this perspective it is very important NOT to use standard sublimation inks (the ones used in the "traditional process") because those inks have a brownish carrier that will stay on

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the media surface and it will be NOT fixed. When some water goes on the media you will have black/brownish stain of ink, it will be a disaster when you will have colored area beside white ones. This will not happen if you will use inks dedicated to the direct printing because the carrier it is transparent. If you have a colored stain it means that the fixation it has not been good enough.

- 5) You need to control the media that it is loaded in the system, some media has coatings that will stick on the calender reducing its operability and creating potential problems of ghosting;