SHEETFED ACTIVITY GROUP

BEST PRACTICE GUIDE

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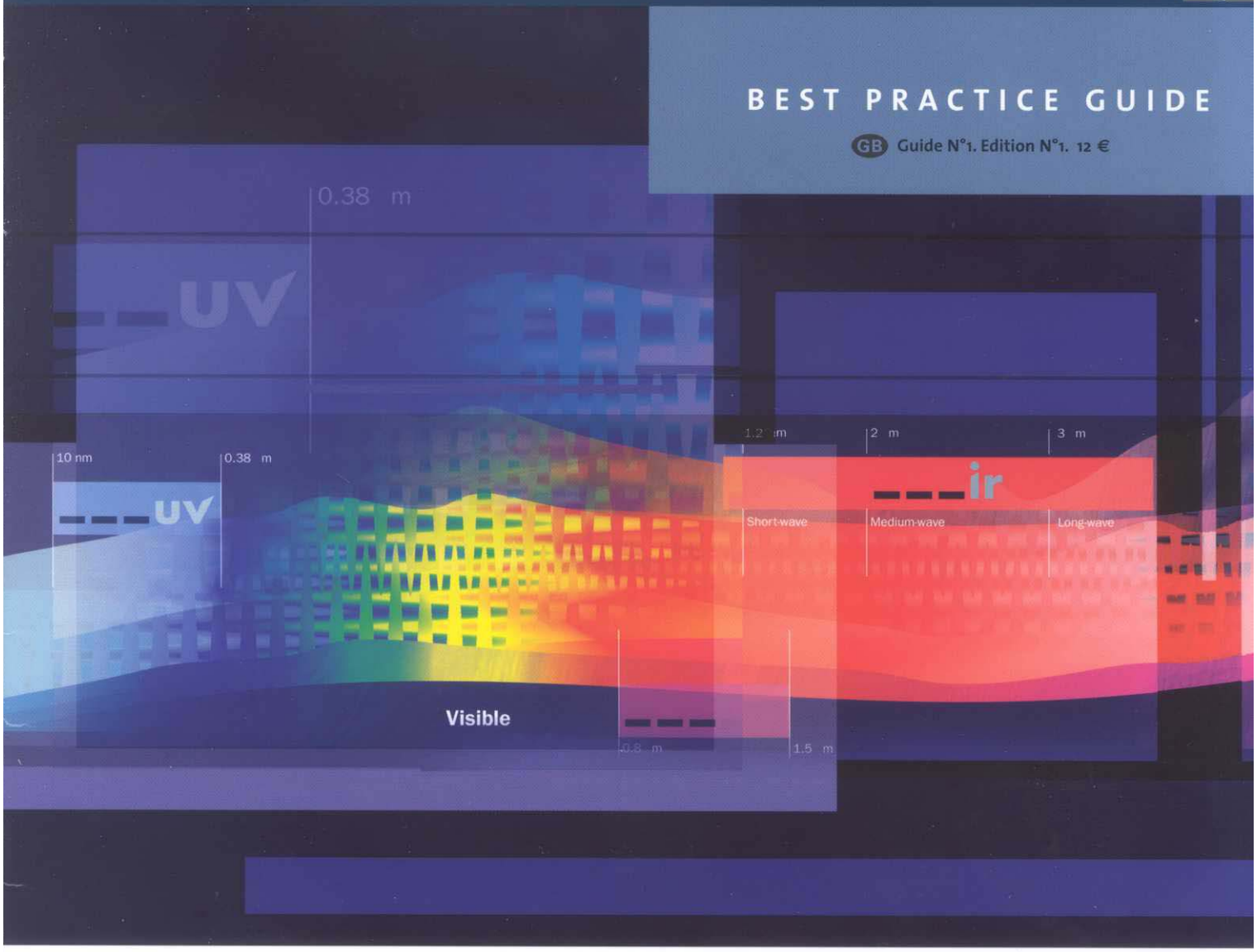

Optimised Sheetfed UV

Best Practice Guide

PrintCity

connection of competence

Optimised sheetfed UV printing

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Guides are available in English, French, German, Italian, Spanish.
To obtain copies contact: GATF Online: www.gain.net or contact member companies (see back cover)

Bibliography, and recommended reading

"Ultraviolet Curing, A Statement Of Its Future Role In The Printing Industry", published by Coates Lorilleux.

"The Impact Of Printing Inks On The Environment", published by Coates Lorilleux.

"Safety Health Environment: Addressing the Issues", published by Coates Lorilleux.

These publications can be obtained from the Internet help desks of Coates Lorilleux and Sun Chemical:
www.coateslorilleux.com/thd
www.sunchemicalhelpdesk.com/SHE/shebrochure/HOME/HTM

IN ASSOCIATION WITH GATF

Prepress: Agfa
Press: MAN Roland R700 LV UV
Blankets: Vulcan from Reeves
Inks and coatings: Sun Chemical
Paper: Sappi Magnostar 135 gsm & 250 gsm
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AGFA adphos eltosch MAN ROLAND REEVES spa sappi The word for fine paper SunChemical UPM WESTLAND

Introduction

Continuing high growth for UV printed products is driven by demand in different markets for the unique attributes that the process can deliver. The demand for higher product quality and greater productivity is pushing both printers and their suppliers to select the right combination of equipment and consumable materials that will optimise the process and improve the skills of their production staff.

Optimal quality and productivity can only be achieved through the effective co-operation between suppliers and printers, who benefit by pooling their skills and knowledge. The objective of this guide is to disseminate generic process knowledge to all the participants in the production chain. The content is organised into sections that address key operating issues, best practices and diagnostics for:

- **Conventional inks + dispersion primer + UV coatings**
- **Full UV inks and UV coatings**
- **UV hybrid inks and UV coatings**
- **Combination of UV and conventional ink systems on same press for alternative operation.**

Best practices are a tool to improve overall performance. Each contributing company has a role in an interrelated production chain; combining their expertise is a positive way of helping to improve overall process performance. The three priorities for high quality UV printing and productivity are:

1- Chemical compatibility of all consumables used in the process system: roller covers and blankets for the types of ink, coating and cleaning agents; ink and coatings selected to match the substrate, finishing and end use.
2- Ensuring that the press is appropriately configured, correctly set up, regularly cleaned and maintained.
3- The prerequisite for high productivity UV printing is thorough staff training.

IMPORTANT NOTE
A general guide cannot take into account the specificity of all products and procedures. We strongly recommend, therefore, that this guide be used in addition to information from your suppliers, whose safety, operating and maintenance procedures must take preference.

Contents

These symbols are used to bring attention to key points:


Best practice


Poor practice

Avoidable cost


Safety risk


Quality issue

Frequently asked questions

Do UV inks have a higher dot gain (spread) than conventional inks?

Yes, but this is compensated in pre-press by adjusting plate setter calibration curves.

Are there problems with stacking UV printed work?

No, provided that the sheets are cured when they arrive at the delivery then no set-off should occur. Attention to lamp efficiency and cleanliness are needed.

Are UV printed products recyclable?

UV printed matter can be disposed of in the same way as other printed waste in terms of heavy metal levels and biodegradability; even the most heavily coated sheets can be processed by modern re-pulping mills using a flotation process.

Can UV be used for toy packaging?

Yes, provided "toy packaging" is specified when ordering the UV inks so that the supplier can select appropriate pigments (same procedure as for conventional inks).

Are UV products suitable for food packaging?

Specific UV inks and coatings that have high consistency in odour and taint testing are available for food packaging. Consistent results require correct curing, careful controls and good procedures. However, the European printing industry recommends avoiding any direct contact between any printed surface and food be avoided. Even if the risk of transfer or migration is very low, it should be avoided.

How does UV odour and taint compare to other products?

A specific advantage of UV is its rapid stabilisation in taint and odour levels as measured by approved standard test methods of food manufacturers. Properly monitored UV printing permits the short lead times between printing and packaging demanded by industry. Cured UV products have a very low potential for causing odour and tainting problems.

Is there a problem from ozone generation?

UV lamps are fitted with extraction systems and the low levels of ozone generated are extracted away from the workplace. The equipment used must be maintained correctly. Ozone is easy to detect and routine monitoring is recommended.

Does UV printing produce other air emissions?

Ozone is the only emission, and is produced by the lamps. In comparison to conventional printing, UV printing produces fewer VOC air emissions and can therefore be used as a control technology.

Is there a problem of ink mist on fast presses?

There are many factors that can influence the level of ink mist. Misting should be avoided or at least minimised since it can affect health, cleanliness and hygiene. High-speed presses should be fitted with mist extraction. Further reductions can be achieved by good press maintenance in roller, plate, and blanket cylinder pressures, press temperature control, effective exhaust and general ventilation.

Are UV products handled in the same way as conventional inks?

Energy curing products can be handled in a similar way to oil-based and water-based products while observing the same high standards of hygiene and working practice. Good housekeeping standards are required and care taken to avoid unnecessary contact with UV products. Always read the health and safety information provided by the supplier and follow the instructions carefully. Eye irritation can be caused by repeated or prolonged exposure to uncured UV products if the suppliers' handling recommendations are not followed. See page 22.

Are toxic materials used in UV inks and coatings?

UV products are formulated from materials other than those known to be toxic. Materials used in UV products are well understood from detailed scientific studies over many years. Spray powder and ink and coating solvents can be eliminated from the pressroom when UV technology is used. UV products are very press stable and this can lead to a reduction in the use of wash-up solvents.

Glossary of technical terms

Absorption (setting):
The penetration of mineral oil and water from the ink/coating layer into the substrate.

Acrylate:
Reactive raw material for the manufacture by photopolymerisation of acrylic thermoplastic synthetic resins. It is the basis for UV sheetfed ink chemistry.

Aqueous coating: (see Dispersion).

Coating (varnishing):
The application of a special covering layer onto a substrate or print by using a printing or coating unit. The covering layer can be functional, e.g. a protective coating, or decorative.

Combi:
Special rollers and blankets for use with mixed production of UV and conventional inks and coatings on the same press (combination).

Combination dryer:
Combines three drying methods, IR, hot air and UV.

Cross-linking:
The process by which (small) reactive monomeric or oligomeric units present in a liquid mixture react irreversibly to create a solid matrix structure

Curing (drying):
The setting of inks and coatings using UV radiation.

DIN 16524/16525:
Tests for prints and printing inks: fastness to water, solvents, soaps, cleaning agents, foodstuffs, light.

Dispersion coating (Aqueous or WBC):
A coating material with the main ingredients of water, polymers and additives; dries by a physical process that can be accelerated by applying warm air.

Dryback (Drawback):
See gloss withdrawal

Edge blackening:
Edges of UV lamps become black with use.

EPDM:
Ethylene Propylene rubber made from non-polar bonded elements; suitable for polar additives such as the constituents of UV inks.

Gloss withdrawal (Dryback):
Oxidation drying of conventional inks and primer continues under a cured UV coating, leading to poor adhesion, low gloss and differential gloss between printed and unprinted areas.

Migration:
A term used to describe relocation of substances in different industrial products during drying.

NBR:
Nitrile Butadiene rubber with polar bonded elements used for inking and dampening rollers; suitable for use with conventional inks containing mineral oil and non-polar bonded constituents.

Metallic pigment coating:
Dispersion or UV coating containing metal pigments that provide gold or silver effects.

Monomer:
Small molecule that can combine with itself or other similar molecules to form a larger molecule after exposure to a light source.

Orange peel effect:
Too rapid IR (infra-red) curing of dispersion coating before lower primer layer is set.

Oxidation drying:
The networking reactions of conventional offset inks exposed to oxygen that generally takes several hours to one day, but can take several days.

Oxygen inhibition:
High levels of oxygen enter the coating and diffuse into the ink layer and deform the surface. The effect also lowers the chemical reaction speed of the overall process.

Photo-initiator:
An additive used in energy curing systems that forms reaction-capable products by absorbing UV rays; networked structures are formed with the molecules of the binding agent.

Photopolymer:
UV networked coatings.

Polar bonding:
Polarity is the electrical forces between molecules that determine their bonding behaviour (similar to joining two bar magnets together, which can only occur if opposite positive and negative ends are placed together); a form of element bonding where atoms become positive- or negative-charged ions that bond together. **Non-polar bonding:** The opposite to polar ion bonding where equivalent elements are bonded by homopolar linkage.

Primer:
A special type of dispersion coating applied to the sheet after it is printed with conventional inks and when UV coating is to be applied over these inks.

Radicals:
Chemically active atoms and molecules with a high energy level.

Tack:
Stickiness of printing ink.

UV inks & coating:
Energy curing that is activated by UV light energy and consists of vehicles, reactive thinners and photo-initiators; exposure to UV light hardens (cures) the ink and coating.

UV hybrid:
Ink system with reduced UV content that permits an overprint of UV coating without the need for a primer; designed for occasional use using conventional roller and blanket coverings; initially developed by SunChemical (HyBryte™).

Water Based Coatings (WBC):
See dispersion.

Why use UV?

	2000	2001	2002	2003
Overprint caotings	53%	53%	53%	52%
Offset	19%	20%	21%	22%
Screen	14%	14%	14%	14%
Letterpress	9%	8%	7%	6%
Flexo	4%	5%	5%	5%
Gravure	0%	0%	0%	0%

UV is continually increasing in use in all printing processes (except gravure). European UV use by segment.
Source UCB/Radtech.

Growing UV demand

The UV market has been growing continuously over many years with an annual worldwide growth rate of around 10% which is almost three times higher than the industry's average growth rate for printed products. UV has also grown strongly in sheetfed and also in many flexo applications.

Process benefits for printed products

The growth of UV is being driven by its value-added attributes that can provide multiple benefits in publication, commercial, packaging and label market applications. The reasons for this are found in the increasing customer demands for:

- The use of a very wide range of substrates (in addition to paper and board) including low-absorption or non-absorption substrates (plastics, foil, metal and heat sensitive substrates).
- Very high gloss effects, sometimes in complex combinations with scuff and scratch resistance.
- A variety of special coatings for functional, tactile and special graphic surface treatments.
- High surface resistance (rubbing and scratching), especially for packaging and publication covers.
- Faster job completion, particularly for short runs, because UV printing can in many cases be immediately finished.

The key business advantage in the UV process is its application flexibility that delivers variable product features and special applications over a wide range of substrates and surface finishes. This provides printing purchasers with creative opportunities to differentiate their products and add functional features to them. Printers can achieve higher value sales to existing customers and attract new business.

In some cases, UV printing and coating reduces total production costs compared to other processes; in others, the higher selling price of UV products provides an improved return of investment even with higher UV production costs.

UV printing is now a dependable process. UV inks are considered to be environmentally friendly because they do not generate VOC (Volatile Organic Components) solvent emissions. For example, in the USA some conventional sheetfed ink distillates are classified as VOC and are subject to legislative control and restrictions – in these areas UV is often classed as the "best available process". In the EC, ink distillates for sheetfed printing are not classified as a VOC hazard.

The value added benefits of UV were first recognised for packaging, but it's use has also grown in commercial and publication applications.
Photo: Sun Chemical.

Production process advantages

- Minimised printed waste – no smearing or set-off.
- Short turnaround time with almost immediate finishing from instant ink curing.
- In-line UV production also avoids separate offline coating operations (reduced waste levels and handling).
- Normally no spray powder is required; however, use of powder on highly static-prone substrates can improve their delivery performance.
- Reduced frequency of changing high delivery piles.

Production process constraints

- Higher equipment investment cost of 15-25% (depending on configuration).
- Replacement costs of UV lamps (UV lamps and IR emitters have similar cost, but UV lamps and reflectors are replaced more frequently).
- UV ink and chemical costs may be higher than conventional inks in some world regions (like Europe) where the conventional inks used are of different quality/price than in other regions (like the US).

Production process comparisons

- UV ink consumption is equal to conventional 4-colour process printing; UV ink waste is lower.
- Widespread European experience shows that average production output should be similar to conventional provided best practice is used (UV curing equipment configuration, ink and coating chemistries and correct operator techniques).
- Total energy cost of UV production is similar to that of the same press configuration equipped with IR/Hot air dryer. Tests show that UV draws 10% less lamp power than IR/Hot air. A comparative total energy running cost audit shows that UV costs about 30% less than IR/Hot air (using German energy costs). The energy necessary to start up a UV lamp is higher than that for an IR emitter that does not start by ignition, the kW rating of UV lamps is also normally higher than IR emitters.

What is UV curing ?

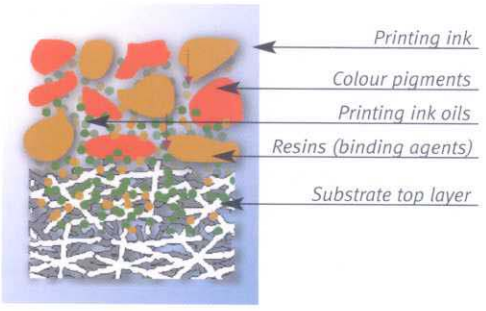
The main differences between UV curing and conventional ink drying lies in their binder ingredients and drying mechanisms. Conventional solvent-based ink relies on the absorption of liquid materials into the substrate, where the ink sets and its resin materials dry by oxidation polymerization to give a scuff resistant surface. This process can take many hours depending on variables like substrate, ink coverage, ink and water chemistry/balance. Assisted evaporation (IR and hot air with warm air exhaust) can accelerate drying of water-based coatings.

The UV ink 'drying' process uses inks that contain a photo-initiator that is reactive to a specific bandwidth and intensity of UV light. After printing, the substrate is exposed to UV light (from lamps housed in the press) that initiates a chemical reaction of the photo-initiators and other UV-reactive components to cure (dry) almost instantly the ink-coating film.

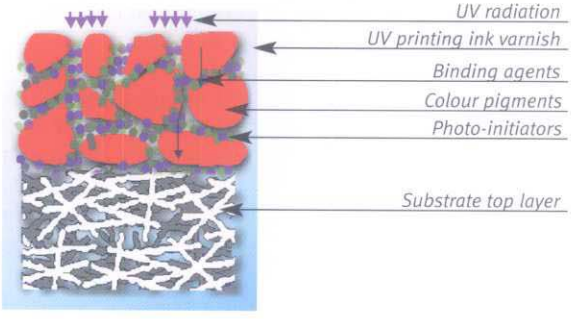
When catalysed by the combination of UV light and photo-initiator, the ink binders immediately react to give a dry ink film (UV ink binders include polymerisable monomers, oligomers and pre-polymers). Sheetfed UV ink and coating systems are based on acrylate chemistry and are generally used in four ways:

- Conventional inks + dispersion primer + UV coatings.
- Full UV inks and UV coatings
- UV hybrid inks and UV coatings
- Combination of UV and conventional ink systems on same press for alternative operation.

Conventional drying (absorption)



UV chemical curing



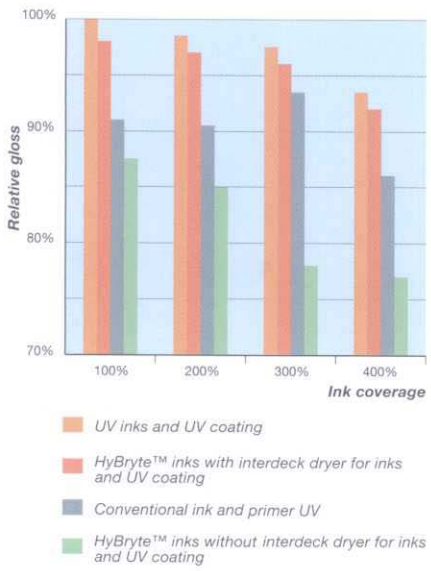
What process combination for which application?

Printing Process	Wet Offset +	Wet Offset +	Wet Offset +	Wet Offset +	UV hybrid+	UV offset	UV offset +	UV offset +	UV offset +
Coating	In-line single	In-line double	Primer +	Off-line double	In-line single		In-line single	In-line double	Off-line double
	WB coating	WB coating	UV coating	UV coating	UV coating	No coating	UV coating	UV coating	UV coating
Printing applications		WB coating		UV coating				UV coating	UV coating
Paper substrates	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●
Folding carton substrates	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●
Plastic and foil substrates	●●●	●●●	●●●	●●●	●●	●●●●	●●●●●	●●●●	●●●●
Metallised substrates	●●●	●●●	●●●	●●●	●	●●●●	●●●●	●●●●	●●●●
Heat sensitive substrates	●●●	●●●	●●	●●●	●●	●●●	●●	●●	●●
Surface chemical resistance	●●	●●	●●●●	●●●●●	●●●●	●●	●●●●	●●●●●	●●●●●
Scuff and scratch resistance	●●●●	●●●●	●●●●●	●●●●●	●●●●●	●●	●●●●●	●●●●●	●●●●●
Tactile and other surface effects	●●	●●●	●●●	●●●●●	●●	na	●●	●●●●●	●●●●●
Overprinting varnishes and coatings	●●●	●●	●●●	●●●	●●	●●●●●	●●	●	●
Food applications (no direct contact)	●●●●	●●●●	●●	●●●	●	●●●●	●●●●	●●	●●
Gloss quality	●●●	●●●●	●●●●	●●●●●	●●●●●	●●	●●●●	●●●●●	●●●●●
Coating quality and ease of use	●●●●	●●●●	●●●●	●●●●	●●●●	na	●●●●	●●●●	●●●●

Comparative performance:
Very good ●●●●●
Good ●●●●
Satisfactory ●●●
Fair ●●
Poor ●

A wide range of process options is available for value added sheetfed printing. These begin with conventional inks and in-line aqueous coating to print on paper and board – where the final gloss is determined by the substrate. A higher gloss alternative is to apply a primer-sealer over conventional inks and then add UV coating. The next step is either UV hybrid or full UV ink – the curing hardware for them is the same, the variable is the number and position of the lamps. 'Combination' is a press equipped to alternate between different ink systems.

Conventional wet offset ink + primer + UV coating: The UV coating provides a scratch-resistant and high-gloss surface without changing proven conventional ink formulations on paper and board. The double coater and end-of-press combination dryer (IR/hot air and UV) allows a dispersion primer to be applied over conventional inks followed by UV coating. High gloss levels can be achieved with fast-absorption 4-colour process inks even with an area coverage of around 300% (similar to UV hybrid inks). The gloss level is influenced by the substrate as well as the configuration and efficiency of the drying system. This approach is common in Europe.



Each UV process combination has a consistent relative performance irrespective of ink coverage. Overall gloss levels reduce as ink coverage increases. Source: MAN Roland.

Full UV Offset (no coating): The essential process for non-absorbent surfaces. Gloss comes only from the inks and substrates (gloss level will be low on all but the best substrates). No value added surface treatment by coating is possible. The inks used must have adequate mechanical resistance (unless they are to be off-line coated or laminated).

Full UV Offset + In-line single UV coating: Provides unmatchable high-gloss finish with almost no change during the curing process. UV curing after the coating unit at the end of the press provides optimum gloss. Pre-heating the coating to about 40°C prior to application can help achieve higher gloss; to a lesser extent a pre-coater lamp might also help.

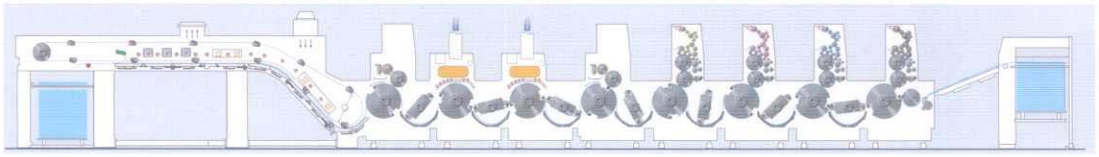
Combination (combi) press: The most flexible combination can run full or hybrid UV, conventional ink, UV coating and/or water-based coating on a press of 10 or more colours.

UV Offset + In-line double UV coating: Allows a wider range of high value added surface finishes to be applied, including mixed matt/gloss coatings and special effect pigments. This approach is mostly used in Europe.

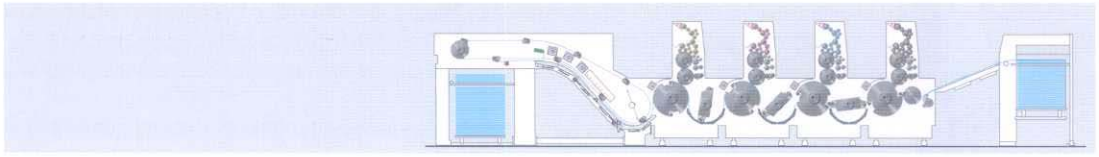
UV hybrid inks + In-line UV coating: UV hybrid inks combine some of the advantages of conventional and UV inks for high gloss coating – their cost is similar to full UV inks. The system is relatively easy to retrofit to an existing press with a coating unit and is mostly used for occasional UV coating on a variety of substrates. (Tests show that UV end-of-press drying alone is not sufficient for high ink coverage except at slowest running speed). As press speed and ink coverage increases (along with gloss level expectations) additional inter-deck dryers are needed. Conventional rollers and blankets can be used for about 30-40% of press operating time with UV hybrid inks; above this level special rollers and blankets are required.

Off-line coating: There can be quality and operating advantages in applying coatings off-line for (a) trade printers/finishers (b) printers who want to run conventional inks at maximum speed and concentrate all coating on to a single line, and (c) UV pre-coating or white opaque inks (backing white) as well as post-print coating. Off-line is simpler with less risk of quality problems and generally gloss results are equal. Coatings may need to be adapted for this method. Off-line units are available with both single and double coaters

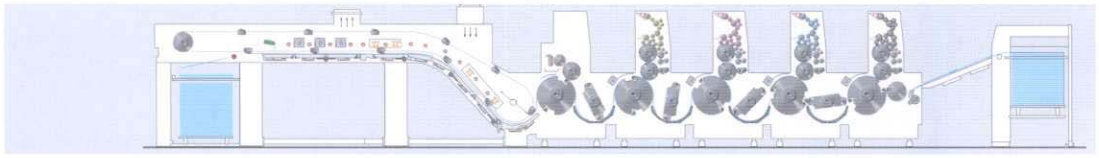
Selecting the right process depends both on the substrates and products to be produced and the proportions of UV and conventional printing on the press. The economic impact of each option needs to be calculated as a total operating cost – investment, operating costs, energy, consumables (ink, chemicals, rollers, blankets) over a range of jobs. Higher equipment investment costs can lead to lower consumables costs and higher productivity, resulting in a lower cost per printed job. However, direct cost comparisons can be misleading because UV printing is a value-added process that has a higher selling price to wider markets and should generate higher sales revenues that will more than offset additional process costs.



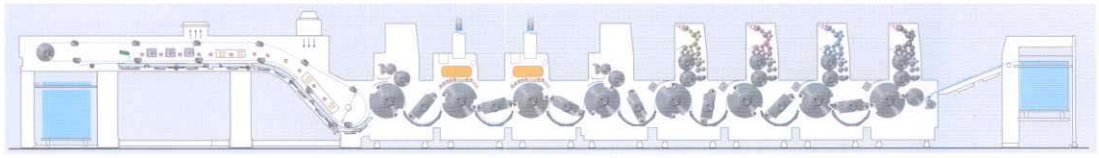
Conventional wet offset ink + primer + UV coating



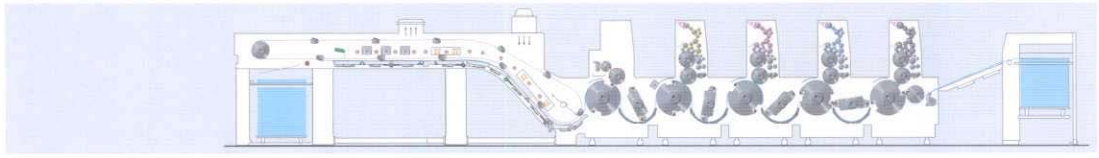
Full UV Offset



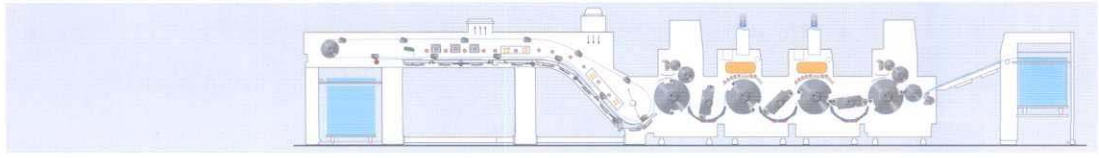
UV Offset + In-line single UV coating



UV Offset + In-line double UV coating



UV Hybrid inks + In-line UV coating

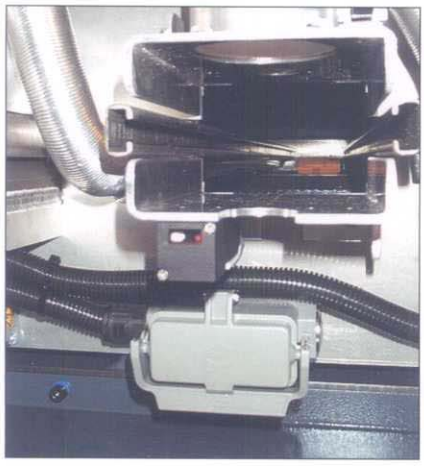


Off-line coating

1 Production system

Press equipment to enable and optimise UV production

Ink hood open to show ink fountain agitator that prevents high-tack UV ink from standing still in the ducts. Photo: MAN Roland.



UV end of press lamp docking station.
Photo: MAN Roland.

Optimum performance is achieved by selecting the right components for the printing applications within a total processing environment with all of the consumables used. Accelerated drying produces heat in the press that also requires some equipment adaptation.

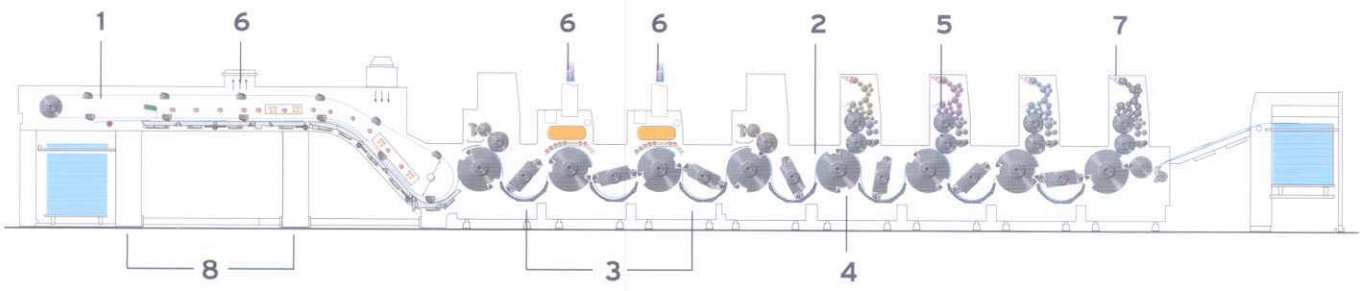
System components overview (standard and optional):

- UV preparation of the printing press (mechanical, electrical, software)
- Cassettes ("docking stations") between print units, coating units and in the delivery to accommodate UV dryers
- UV dryers (inter-deck and end-of-press) or combined IR + hot air + UV dryer.
- Exhaust systems between print units and in the delivery to remove ozone, odours and humid air
- Heat extraction system around UV lamps cassettes, between units and in the delivery. Heat exchangers are normally standard components.
- Heat extraction system for impression cylinders when using heat-sensitive substrates.
- UV or combi rollers (for inking and coating systems)
- UV or combi blankets (for inking and coating systems)
- Temperature controlled ink rollers (because of high tack of UV inks)
- Ink mist extraction hoods
- Ink fountain agitators to prevent high-tack UV ink from standing still in the ducts and eliminate manual stirring
- Dedicated coating unit with chambered doctor blade and anilox roller. The geometry of the anilox screen rollers strongly influences coating flow (it is essential that the surface cells do not fill in).
- Coating conditioners to pre-heat coating to 40°C to ensure even spread, obtain highest gloss and minimise foaming.
- Additional washing tank system for combination presses alternatively running conventional and UV inks.
- Extended deliveries and transfer modules between double coaters
- Shadow-free grippers in the delivery gripper systems
- Safety equipment (guards etc.)

Pipes and pumps:

- Avoid pipe systems containing copper because contact with UV products can initiate the hardening process.
- Ink pumps should use teflon bearings because UV products are not self-lubricating.
- Coating lines should use non-contact pumps (no bearing maintenance) that also allow fast changeover between different coatings without the cleaning required when using conventional pumps.

1 Shadow-free grippers,
2 UV inter-deck units,
3 Transfer modules between coater,
4 Impression cylinder washing device,
5 Temperature-controlled ink rollers,
6 Suction devices,
7 Ink fountain agitators,
8 Extended delivery with end of press dryer.
Source MAN Roland



UV inter-deck curing flexibility

Self-contained plug-in modules take 2-3 minutes to change and can be installed between units for flexibility and to give production back-up. They are positioned according to the needs of each job depending on ink colour, sequence and coverage. The maximum number of modules is a UV lamp for every printing unit. Fewer units can be used; the recommended minimum is one UV module for every two print units.

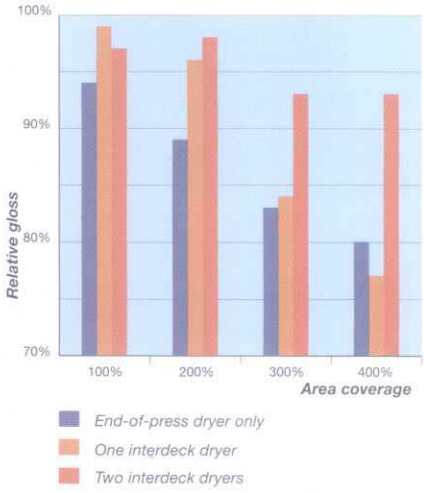
Place an inter-deck UV dryer after opaque white, metallic colours, colours printed 15% above standard density, and dark colours (black, blue, green) and or colours that cover more than 80% of the forme.

Always remove UV lamps from the delivery when using conventional inks and spray powder. To avoid surface contamination a dummy unit, without which the press will not start, is inserted in their place as a safety device.

UV hybrid inter-deck: UV end-of-press curing alone may not be adequate for high ink coverage at high speed. Tests show that, for low ink coverage on high gloss paper, one inter-deck dryer after the last printing unit is sufficient but two are needed for mid-high ink coverage on low gloss substrates.

UV coating end dryer and cartridge: For best results, the UV end-of-press dryer should be as close as possible to the delivery to allow the coating to spread as evenly as possible prior to curing.

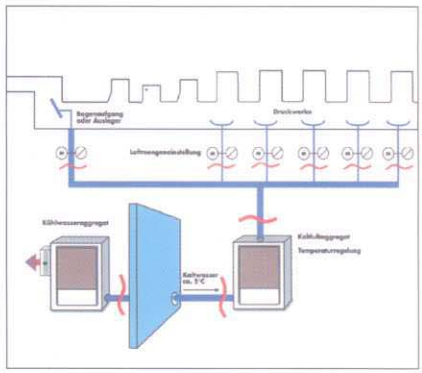
Complete production flexibility is available if all press units have a UV lamp station. The variable positioning of available UV lamps in these stations depends on the requirements of a given job (colour sequence, brightness and coverage).



The achievable gloss level of coating, when applied over different ink area coverage, is determined by the number of inter-deck dryers used with UV hybrid printing systems. Source MAN Roland.

Combination IR + hot air + UV dryer systems

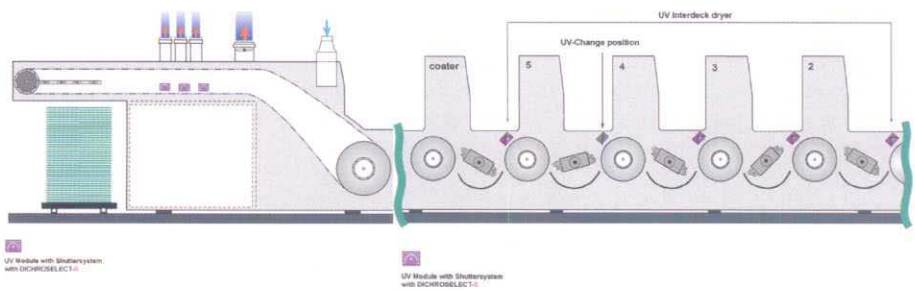
End-of-press dryer for printing presses with in-line coating units and UV equipment that is used for alternating processes:
Hot air: For water-based coatings, IR (Infrared) lamps heat the aqueous content to create water vapour that is extracted by hot air knives and exhausted with a suction system.
IR segment: Helps reduce ink viscosity (of normal offset ink – not UV ink) for faster substrate absorption.
UV segment: Ensures final curing of UV inks (both full and hybrid) and UV coatings



Cold air device on impression cylinder and in the delivery for heat sensitive substrates. Source MAN Roland.

IR inter-deck

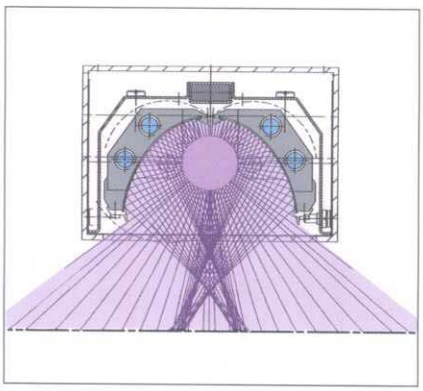
- IR inter-deck dryer before the first coating unit warms up the sheet to help more evenly distribute the coating film.
- IR inter-deck unit before the second coating module dries the first coating and warms the sheet to help prevent formation of an orange skin surface when using aqueous primer (caused by particles of water trapped in the primer layer leading to gloss draw back—too much energy sets surface only).
- IR inter-deck dryers accelerate oxidative drying.

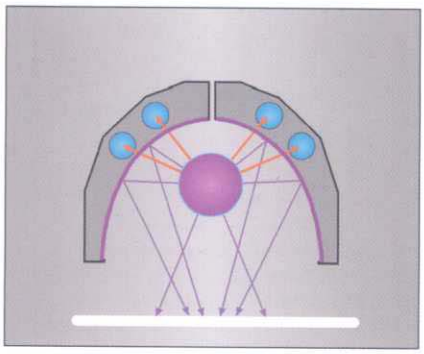


Combination IR +hot air + UV end-of-press dryer for double coating units that are used for different processes in alternating mode (a) Conventional inks and coatings (only IR and hot air is needed) (b) Conventional inks, primer and UV coatings (UV, IR and hot air) and (c) UV inks and UV coating (only UV) used with inter-deck dryers. Source MAN Roland.

UV lamps and reflectors

UV lamps





About 65% of lamp radiation travels indirectly from the lamp to the substrates. The properties of the reflective materials used in the reflector and its profile (elliptic, parabolic, variable, combi) significantly determine UV lamp efficiency.

UV emitters are typically a quartz tube containing mercury in an inert atmosphere. High quality quartz assures a transparency of up to 90% of UV radiation and resistance up to 800°C. Mercury is used because it emits radiation over a wide range of the spectrum to cure colours that are generally used in printing. For special applications (such as opaque white, high ink film weights and special colours) doped lamps may be required (cobalt, gallium, indium, iron, lead). UV lamps require a transformer to provide an electrical current of several thousand volts.

Mercury UV lamps are very reliable but their output declines continuously as they are used. Deterioration is related to (a) the number of operation hours (b) the number of times they are switched on and off (c) cooling system efficiency and the cleanliness of the tube and reflector. Generally, lamps have a guaranteed lifetime of 1000 - 1 500 hours depending on supplier and type. A new generation of UV lamps using a circular halogen process largely avoids edge blackening (from corroded electrodes) and significantly postpones inner contamination of the whole lamp (electrode material deposits), giving them a very long lifetime if properly maintained.

High electrical lamp rating does not necessary mean that the system delivers high UV efficiency with a low level of heat generation at defined energy consumption. Efficiency depends not just on the power rating of the lamps but also on their quality and the system profile – this varies between suppliers and designs, and affects curing and energy efficiency, e.g.

- To reduce electrical stand-by costs and fire hazards the lamp system should include a shutter that automatically closes during a machine stop. An integrated shutter positions a lamp closer to the substrate and gives a 20% higher efficiency (it also needs less cooling and energy than other designs).
- The reflector profile should focus rays for highest intensity. The ideal is minimum direct radiation with highest intensity focussed into a narrow area.
- High intensity curing is preferred that rapidly seals the ink surface in order to minimise oxygen inhibition effect (otherwise high levels of oxygen diffusion will deform the coating surface).
- Avoid pre-irradiation as this increases the power needed for main curing.
- Post-irradiation is only recommended for heat-sensitive substrates that may suffer from register problems resulting from heat generated during inter-deck curing.

Reflectors

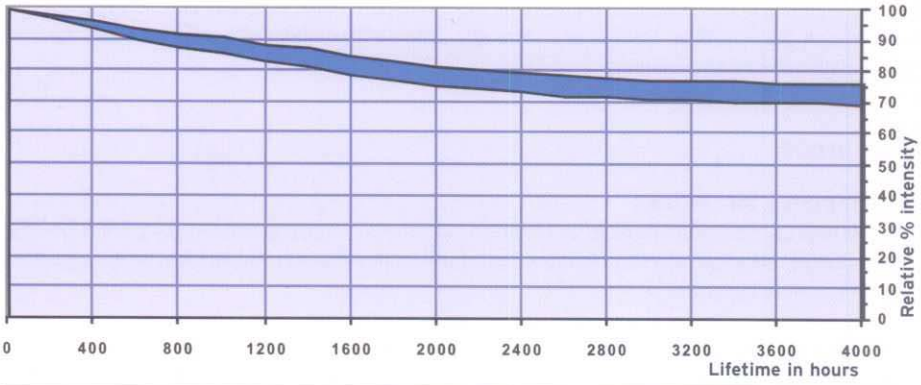
Only about 35% of lamp radiation travels directly from the lamp to the substrates (primary energy). The remaining (secondary) energy is redirected onto the substrate by a reflector. Overall lamp efficiency is determined by the properties of the reflective material used and the reflector's profile. Reflectors should provide maximum UV radiation for drying at minimum energy consumption with minimal heat build-up. The decisive factor in curing is the amount of UV light that reaches the substrate. The UV module should be as close as possible to the substrate because UV intensity declines dramatically with increasing distance from the substrate surface.

UV reflectors are mostly made from aluminium or glass – which have almost identical reflective performance. Aluminium is preferred because users can change reflectors themselves when they are dirty (glass requires a specialist technician) and there is no risk of glass flying into the press should a reflector disintegrate. For heat-sensitive substrates a dichroitic reflective coating uses a selective mirror to reflect UV rays and to absorb most of the IR rays.

Cooling

The surface temperature of UV lamps can be up to 800°C and effective cooling is required to avoid damage to either the substrate or the press system. Water-cooled systems filter out and absorb most of the heat generated by IR rays. It is essential that the cooling water is pure (demineralised) and free of bacteria.

Service life of UV lamps



Lamp lifetime is variable between different designs and suppliers. This example shows that UV lamps can achieve a life of 4 000 hours in the laboratory, but under tough practical conditions service life is around 1 500 hours – depending upon supplier and type. Longer service life is achieved by an optimised internal circuit process to make the lamp more durable and to ensure that the intensity at the lamp edges does not decline too quickly.
Source: Everclear/Eltosch-MAN Roland.

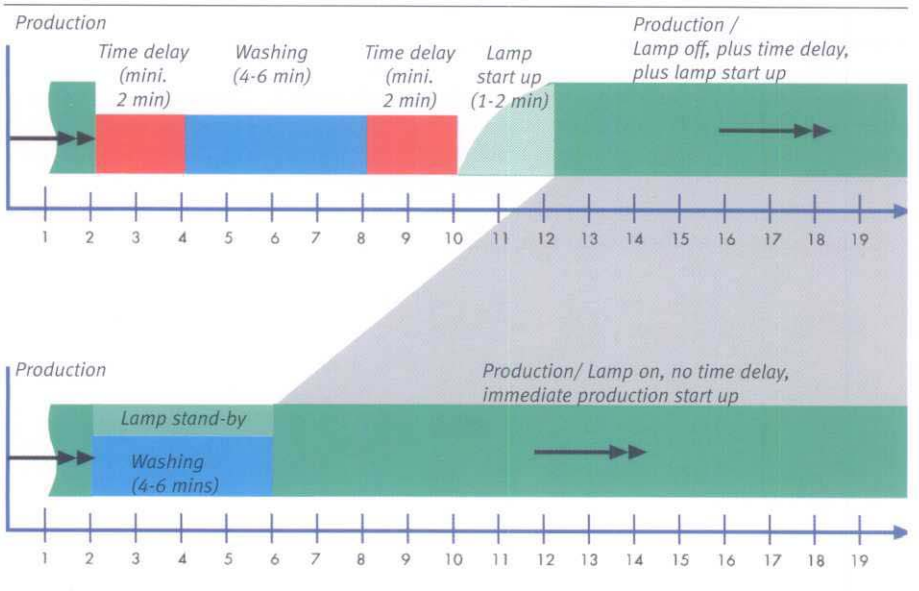
Curing system control

Precise UV dosage should be matched for each ink colour at all press speeds. The control system should allow individual programmes of each UV lamp output module to achieve extremely fine dosing (particularly for heat-sensitive substrates) plus individual programming of each UV module in the end-of-press dryer. Other desirable features include step-less output regulation with dimmer; integrated shutter system to prevent radiation into the press during stand-by operation; immediate dryer power-up from stand-by to production; monitoring of cooling systems.

Special lamps

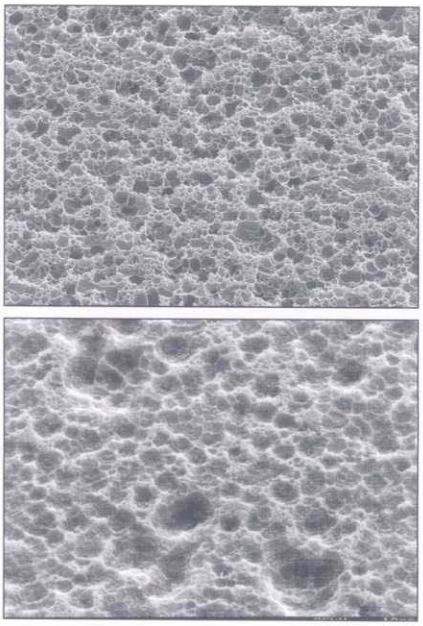
UV opaque white: Ink used in printing plastic film has different absorption ranges than standard UV inks (white pigments absorb very well in a different range than standard pigments). This means that during curing they are in competition with the photo-initiators. A higher level of energy is often used to ensure curing but this can cause problems on heat-sensitive substrates. A white cure UV module (inserted in place of a standard lamp) can improve curing performance by up to 25%.
Primer carbon lamp: For inter-deck double coating dryers to ensure the highest obtainable gloss result and also give significantly better primer curing at high speeds.

Increased production time by reducing downtime



The safety requirements for UV printing require that the UV inter-deck unit(s) must be switched off during the blanket washing cycle (volatile solvent explosive risk). This means that a washing cycle takes about 4 minutes. A recent innovation allows the dryer to run in stand-by during blanket washing (no slow-down and re-start) to reduce significantly total cycle time.
Source: Eltosch.

Compatible consumable products



Due to their finer pore structure Nitric-grained plates (above) carry more fountain solution than Hydrochloric surfaces (below).
Source: Agfa.

Optimum printing performance requires chemical compatibility of all the consumables used in the process system. Plates, roller covers and blankets are made from materials that interact with the different chemical substances and fluids that they transport – inks, coatings and washing agents. There is an optimal roller, blanket and plate mix, along with dedicated washing agents, for any combination of inks and coatings.

Pre-press

Offset plates for UV inks

UV inks take up less water and have less fountain consumption than conventional inks. The ink/water balance in UV printing is therefore more critical and the influence of the offset plate on the ink/water balance is more important.

The aluminum substrate, its graining and anodizing have an influence on the ink/water balance when printing with UV inks. In general, HNO3 (Nitric acid) grained plates are preferred because their fine pore structure carries more fountain solution than HCl (Hydrochloric acid) grained surfaces. Different plate substrates and their graining can influence fountain consumption. In practice, all types of plate substrate types can be used with UV inks – provided that the ink/water balance and the type of fountain solution are optimised for UV. However, the highly polar components of UV inks and blanket washes can damage the light-sensitive layers of the plates. The resistance of the plate to these components is more or less critical depending on the working principle of the plate. In Europe about 80% of the sheetfed market uses positive plates, whereas Scandinavia and the USA use about 90% negative plates

Analogue negative working plates

All negative plates have some resistance to UV inks and washes; however, their maximum run length in UV printing is lower than with conventional inks. The most popular negative working plates are diazo based. Other types include photopolymer and hybrid systems (diazo-photopolymer combination). Points:

- Positive analogue and photopolymer plates can be used for printing UV inks for short runs.
- Baking photopolymer plates doubles their run length stability.
- The type of washing agent has a high influence on chemical resistance and run length. Always make a drop test with the chemicals in use (washes, cleaners, fountains).
- Run length is increased if higher plate exposure energy is used.

Analogue positive working plates

Diazo resin-based plates are the most popular analogue positive plate. There are also some special plates for UV printing only. The chemical compatibility of positive plates should be assessed using a drop test. Resistance against organic products (e.g. glycolether based) is lower than against water-based products (e.g. with 40 % diacetone alcohol). Points:

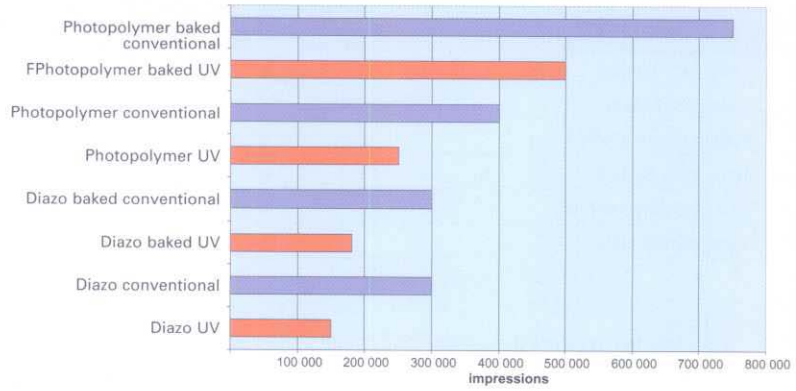
- Special UV-plates are better than standard plates
- Standard baked plates are far better than special UV plates.

Tests to assess plate suitability for UV inks, washes and cleaners:

Chemical compatibility: A drop of test fluid is placed on the plate and left for a certain time (between 1 minute and several hours depending on the type of chemical and its application (e.g. longer contact time for fountain solutions than for plate cleaners). Its affects are then assessed on the image areas (whether or not dissolved, ink receptivity, run length) and the non-image areas (damage of plate substrate).

Plate-print distortion: Coat part of the image with the UV ink/coating and leave for 24 hours, clean the plate, then print test to ascertain any image distortion.

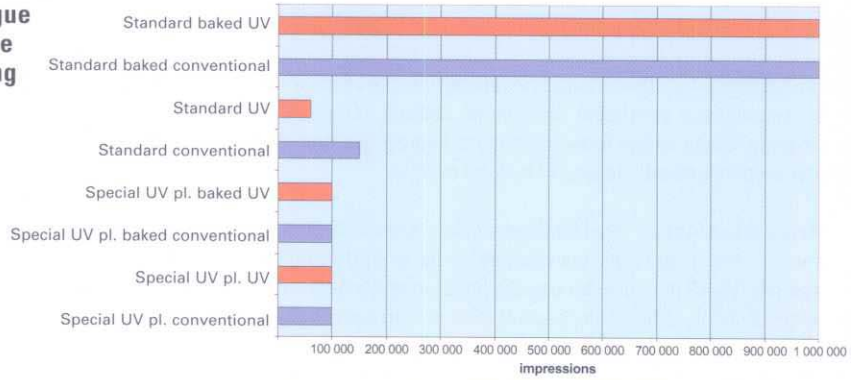
Analogue negative working plates



Run lengths of analogue negative working plates demonstrate that UV applications have less resistance than those using conventional ink. Baking plates doubles their maximum run length.
Source Agfa.

Conventional ink
UV ink

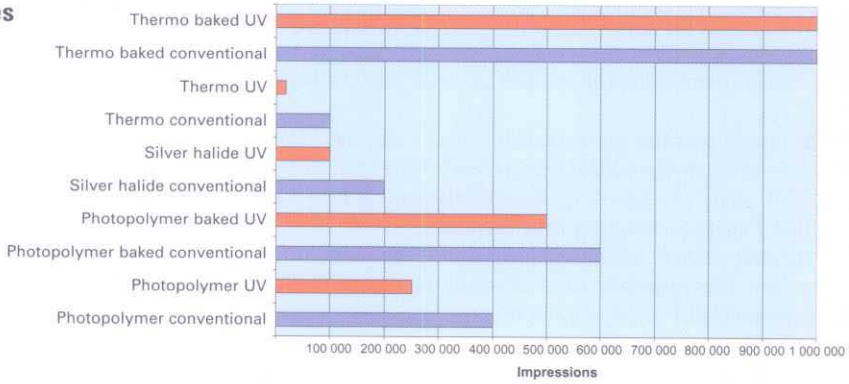
Analogue positive working plates



The run lengths (in thousands) of analogue positive working plates shows that special UV-plates are better than standard unbaked plates but that standard baked plates offer hugely superior run length.
Source Agfa.

Conventional ink
UV ink

CtPlates



Run length of a digital plate based on silver halide technology (Lithostar LAP-V Ultra) is strongly influenced by different inks and fountain solutions. All of the fountain solutions in the test contain 10% IPA alcohol.
Source Agfa.

Conventional ink
UV ink

CtPlates

All digital plates using silver halide technology are based on the DTR (Diffusion Transfer) principle. Run length of these plates (e.g. Lithostar LAP-V Ultra) is strongly influenced by different inks and fountain solutions. The water demand and lithographic properties of the background are the same as analogue plates because the substrate graining and anodizing is similar. The poor roll-up properties of some UV inks requires optimisation of the ink-fountain combination, which also increases run length (to about 50% of the average achieved with conventional inks).

Digital positive working plates: Resin-based plates have the same lithographic properties and run length as analogue positive working plates. Their chemical resistance and run length can be improved by baking.

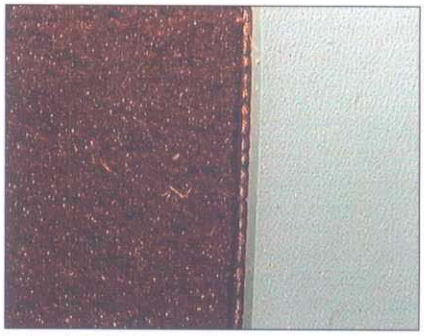
Digital negative working plates: Photopolymer-based plates have the same lithographic properties and run length as analogue negative working plates based on photopolymer technology. Their chemical resistance and run length can be improved by baking.

New plate developments for UV printing include: unbaked positive plates that give the same results with UV inks as with conventional inks; digital plates performance equal to analogue plates; improved resistance against all UV washes; optimised morphology of the light sensitive layers (because smoother surfaces have a higher chemical resistance); and better mechanical plate resistance from improved graining and anodizing.

Coating formes

Application / Coating formes	Flood Coating	Knock-out Coating	Spot Coating
Sticky back blanket	•	•	-
Strippable blanket	•	•	-
Stripping blanket +PES	•	•	-
Sticky back PU film	•	•	-
Pre-cured polymer plate	•	•	-
Photopolymer plate	•	•	•

Use blankets with open cell compressible layers to make stripping easier. Photo Reeves.



Strippable blankets surface: the top printing face and non-printing black area are evident. Photo Reeves.

It is essential to select the coating and image carrier appropriate to the application:
Flood: Complete coating of a full sheet.
Knock-out: Geometric cut-outs of non-coated areas (glue flaps, book spines and ink-jet address panels).
Spot: Any image shape or size for selected areas with precise registration.

The surface properties required for reliable coating transfer are good wetability to ensure a constant thickness layer, consistent transfer, no coating accumulation, resistance to swelling, and easy cleaning. Some image formes are more appropriate than others – depending on the application, preparation method and type of lock-up system.

Strippable blanket: Used for flood and knock-outs. The fine elastomeric surface optimises coating transfer and most types are compatible for both UV and water-based coatings. Relief depth is typically 0,8-0,9 mm to avoid coating build-up and too frequent washing. The 1,95 mm carcass has layers of cotton, a thick compressible foam and an easy-to-peel stripping layer. Elastomers have good affinity with conventional ink but not with aqueous or UV coatings, and the quantity of coating transfer and gloss is generally inferior to a polymer plate. Newer stripping blankets use either a mylar carcass or a PES backing sheet to improve dimensional stability for better registration and are re-usable (about 10 times for overall coating and about 5 times for knock-outs). Mylar helps avoid deep cuts and carcass damage – for barred blankets the cotton canvas on the backside also helps ensure adhesion. Blankets can be stripped on- or off-press, either manually or by a CAD plotter.

Pre-cured polymer plate: Used for flood, knock-out and spot; is more accurate than a stripping blanket and can be used for repeat orders. Plates can only be processed out of the press (hand cut or CAD plotter) and the image distortion factor has to be taken into account. Plate type selection:
• Direct coating – Polyester base + polymer;
• Indirect coating– aluminium base plate + polymer; or Polyester base + compressible layer + polymer. PES is slightly more resistant than aluminium and a minimum 0,30 mm thickness is recommended. Pre-cured transparent polymer plates are a more recent option.

Plastic film + sticky backing: For knock-outs. Transparent film mounted on top of a developed offset plate.

Photo-imaged photopolymer relief plate: The best solution for precision spot and knock-out coating because of their fine detail, register precision and durability (about 1 million impressions). Solvent-washable flexo plates are recommended for UV coating (photopolymer on PES base, typical thickness of 1,14 mm). The processing of this plate requires a significant investment in equipment and they are usually imaged by specialist trade shops.

Sticky back blanket: Used on old presses for flood and knock-out coating from a printing unit.
• Indirect coating – the offset plate is replaced by a thin polymer plate or a sticky back blanket laminated on to an aluminium plate. The coating is transferred from the dampening system onto the polymer plate then transferred to the blanket and released onto the substrate.
• Direct – the print unit blanket is replaced with a coating blanket using a strippable blanket of 1,95 mm thickness.

Substrates

Paper and board

Economic aspects and technical suitability both need to be balanced when selecting the substrate, inks and coating to achieve a desired gloss. The properties of the substrate can influence gloss results by up to 30% (independent of the grade of coating on the substrate) depending on the amount of ink and coating applied.

Porosity and surface

The flatness of the surface and the paper coating absorption properties influence the coating results. Papers with a very smooth surface and/or a low porosity prevent high absorption into the sheet and are very suitable for UV coating. However, they may also affect ink holdout. On the other hand, papers with a rough surface and a low porosity do support ink holdout, but their rough surface may give rub resistance problems.

- High porosity can limit achievable gloss level as it allows the ink to sink into the substrate.
- High absorption of ink into the substrate surface may lead to an incomplete cure (photo-initiators and monomers sink into the substrate).
- Low porosity and very smooth surfaces (cast coated) can limit ink adhesion.
- High surface roughness improves adhesion but can reduce scuff resistance.

Influences of heat and light

Radiated heat increases the temperature in the printed pile. Potential side effects include blocking (sticking together of the sheets) and sheet flatness. Relative humidity can play a role when the temperature is too high and/or curing incomplete.

Paper discolouration (yellowing) may occasionally occur after UV coating or laminating on some substrates because optical bleaching agents as well as becoming active with daylight are also sensitive to UV light from curing. This effect gradually decreases under extensive UV radiation. It is important that the paper contains optical bleaching agents that are stable enough to undergo UV processing with only a small loss of brightness and without becoming yellow. Papers with a high basic brightness level of the pulp and fillers tend to be more resistant.

An undesirable odour can also be caused by a chemical process of some types of latex binders in the paper coating in combination with UV light.

Consultation

Many seemingly difficult applications of UV on paper substrates can be resolved with the selective use of materials and adapted procedures. When in doubt about the use of a product consult your supplier(s) for advice before committing yourself.

Plastics and special substrates

The use of synthetic substrates printed with UV continues to grow in a wide range of applications. Substrates can be transparent or coloured, flexible or rigid, single materials or complex combinations of materials. These include:
ABS Acrylonitrile-butadiene-styrene copolymer • PC Polycarbonate • PE Polyethylene • PETP Polyethylene Terephthalate • PLA Polyiactic acid • PP Polypropylene PS Polystyrene • PVC Polyvinyl chloride • Aluminium foil-Paper board • Metallised polyester-Paper board (generally requires a special coating pre-printing) • Multi-layer complex substrates (composites) • PE coatings-Paper board

Some complex and synthetic substrates are subjected to corona treatment in order to improve the adhesion of ink to their surface by oxidation. Measurement of the surface tension indicates the effectiveness of the treatment and if it is suitable to be printed. Consult your ink supplier for optimum selection of inks for substrates

Special inks for plastics have a surface tension of 32-35 mN/m (milli-Newton/metre) when they are dry and the surface tension of the substrates needs to be about 10 mN/m higher to assure bonding. The surface tensions of synthetic is increased to this level by corona treatment.

		mN/m
PE	Polyethylene	31
PP	Polypropylene	29
PS	Polystyrene	32-35
ABS	Acrylonitrile-butadiene-styrene copolymer	33-36
PVC	Polyvinyl chloride	39-40
PLA	Polyiactic acid	38-39
PC	Polycarbonate	46
PETP	Polyethylene Terephthalate	43

Substrate adhesion and flexibility for UV printing

This table shows the adhesion and flexibility of a typical sheetfed offset full UV ink for use in packaging of cosmetics, liquor, pharmaceuticals, personal hygiene and similar products (it is not a 'confectionary' ink for paper and board only nor a full UV ink for rigid and semi-rigid plastics).

Ratings:

100	*= excellent adhesion.*
75-80	*= normally excellent adhesion but new substrate qualities should be tested with the inks and coatings to be used.*
50	*= normally acceptable adhesion but care must be taken and pre-testing is essential.*

Coated papers	**100**
Coated Boards	**100**
Polyethylene	**100**
Polyester	**100**
Acrylic and PVdC coated	**100**
Polystyrene	**75**
Coated Thermal paper	**100**
Metallised Polyester	**100**
Synthetic Papers	**80**
PVC	**100**
Polypropylene	**75**
Acetate	**50**
PET/APET	**50**

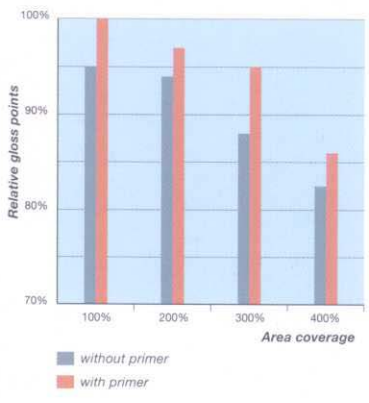
Ink & Coating selection

Coating application	Coating Unit		Coating type			Drying method		
	single	double	Aqueous	Oil-based	UV curing	Hot Air	Infra-red	UV
Clear Matt								
Clear Gloss								
Clear Silk/semi matt								
Primer								
Protective Sealer/Neutral Coating								
Obliterating, Silver or other (Lottery)								
Encapsulated Perfume ('scratch and sniff')								
Metallic Effect								
Pearlescent Effect								
Cationic curing								
Blister pack (thermo bonding board/foil or board/board)								
Substrate pre-coatings								
Opaque white								
Pigmented coatings								
Functional Barrier (water, oil, grease)								
Optically Brightened								
Multi-unit perfecting								

Regularly used/readily available
Possibly available but not regularly used
Not usually used or not relevant

The interactions between ink, coating and substrate along with the desired end-use characteristics determine the type of coating required – the type of coating unit is an additional factor. The choice of finished surface ranges from those that are brittle with high mechanical resistance to more flexible coatings with lower resistance properties.

- The surface smoothness of cured UV coating is influenced by the content of wax and silicone derivatives (slip agents). These additives impair mechanical and temperature resistance, gluing, deep-freeze resistance, wetting and spreading. After curing, slip agents rise to the surface and show fingerprints when the surface is touched.
- UV flood coatings need good elastic properties for trimming and die-cutting to ensure good quality edges.
- There is no universal ink or coating for all substrates.



Gloss levels are improved by using a UV primer over dry hybrid inks prior to UV coating.
Source: MAN Roland.

Conventional inks + primer + UV coating

Conventional offset inks and UV coating have incompatible chemistries and an aqueous primer coating is used between them to allow a UV coating to be applied. A considerable amount of water is applied during primer coating and this must be removed by substrate absorption and accelerated evaporation prior to UV coating. Gloss is improved by using a fast drying primer suitable for the substrate. The properties of the substrate, ink film and coating thickness affect the gloss level. Achievable drying speed, flexibility, penetrability, trapping, viscosity, gloss and bonding depend on the base material and additives used. The ink composition and its affinity to the primer determine the bonding of the coating layer, which only becomes definitely stable several days after printing – gloss withdrawal may occur some time after the job is finished.

Consult your ink maker to select a UV coating adapted for use over conventional printing inks and the application equipment.

Advise the ink maker if UV coating will be applied off-line to ensure that ink pigments are resistant to UV coating and to avoid using wax materials that may compromise the inter-coat adhesion and final flexibility of the job.

⚠ Some conventional inks are formulated to be slower setting and this can lead to serious gloss withdrawal after the primer and UV coating are applied (difference of gloss between printed and non-printed areas). Slow setting ink formulations for special colours are often selected when the printing sequence is not known in advance; however, some formulations are not suitable for primer UV operation – verify these with your ink maker.

UV inks + UV coatings

These produce the highest gloss level that does not change during curing. The gloss level of UV coating is strongly related to the type of ink selected and the volume of coating. Fast-absorption inks should be used to maintain gloss at a good level. However, the risk of mottling restricts the latitude for absorption (depending on the substrate and the end quality required). Optimum gloss requires foam-free coatings to avoid spots on the finished surface.

UV hybrid inks + In-line UV coating

The low UV-content ink system uses a single coater to apply UV coating without primer – but the coating must be matched to the specific UV hybrid chemistry. For about 10% of press operating time conventional rollers and blankets can be used without risk because UV hybrid has lower swelling characteristics than full UV ink. Above this level there is an increasing risk of swelling and special combi rollers and blankets are recommended. There are significant differences between hybrid UV ink formulations (particularly between ingredients used in the USA and Europe) that can strongly affect ink/water balance stability and ink density required (ink cost is similar to full UV inks). Caution: not all conventional washing agents can be used on UV hybrid inks and some specific conventional blanket washing agents might encourage swelling.

Always test roller and blanket compounds prior to running hybrid UV. Provided correctly formulated hybrid UV inks are used, most blanket and roller problems are caused by incompatible washing agents or poor procedures.

It is important that the ink supplier knows which inks will be wet-trapped to ensure that the tacks are correctly set.

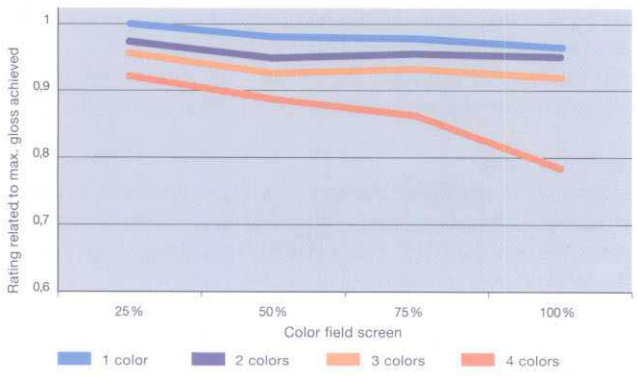
Using UV ink for special colours in the printing unit directly before an inter-deck dryer will achieve outstanding gloss because the coating is applied over a dry surface – which also reduces gloss dryback risk. Special surface effects can be created using a mix of hybrid and conventional inks with UV coating.

Primer: Provided inks and coating are correctly selected for good inter-coat adhesion there is no need for a primer to be used when printing off-line UV coating over dry UV inks. UV primer can be used to seal (protect) the surface of conventional ink jobs when differences in absorption appear:

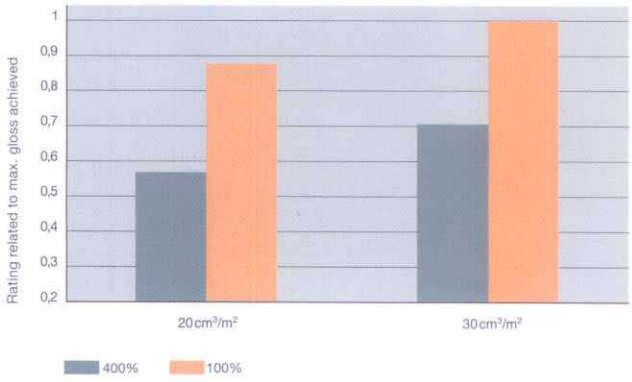
- If the substrate absorption is very high there may be significant absorption of coating in non-printed areas with a corresponding loss of gloss.
- Different thicknesses of ink layers (and between ink layers) and the non-printed areas can lead to differences in absorption of the sealer and be responsible for differences in gloss (drawback).

Neutral sealer: Gives functional protection to the printed surface to avoid marking in post-press processing and accelerated drying. It provides only a similar gloss to the substrate.

Pre-coating: This is used for different purposes including upgrading substrate surface and printing white opaque primer (wet-on-wet or wet-on-dry). Pre-coating is often made off-line or as a separate first pass through the press.



When UV coating is applied over conventional inks the final gloss level is related to ink volume. Source: MAN Roland



UV gloss level over conventional inks and primers changes over time and it takes several days before hardening and drying is complete. Source: MAN Roland

Rollers & Blankets

Consumable	Printing unit					Coating module	
	Blanket	Roller in the ink unit	Forme Dampening roller	Metering Roller	Washing Agent	Blanket	Roller
Conventional	Standard	Standard	Standard	Standard	Standard		
Conventional with aqueous coating	Standard	Standard	Standard	Standard	Standard	Standard & strippable/coating	EPDM 80°ShA
Conventional with UV coating	Standard	Standard	Standard	Standard	Standard	UV & strippable/coating	EPDM 80°ShA
90% Conventional / 10%	Standard	Standard	Standard	Standard	Standard / UV custom mix		
80% Conventional / 20% UV	Combi	Standard	Standard	Standard	Standard / UV custom mix		
< 80% Conventional , UV > 20%	Combi	Combi	Combi	Combi	Standard / UV custom mix or Combi Wash		
Full UV	UV / EPDM	UV / EPDM	Combi	Combi	UV		
Full UV with coating (disp)	UV / EPDM	UV / EPDM	Combi	Combi	UV	Standard & strippable/coating	EPDM 80°ShA
Full UV with coating (UV)	UV / EPDM	UV / EPDM	Combi	Combi	UV	UV & strippable/coating	EPDM 80°ShA
UV - Metallic Inks	Combi	Combi	Combi	Combi	UV		
Hybrid UV	Combi	Combi	Combi	Combi	Hybrid Wash		

Sources: MAN Roland, Reeves, Westland.

Chemical compatibility

Roller covers and blanket faces are compound materials that interact with the different chemical substances and fluids they transport. Therefore, they must be compatible for the ink type, coating and cleaning agents used – if not the blankets and rollers will swell causing a rapid decline in quality, productivity and will need replacing. For any combination of inks there is an optimal roller and blanket covering solution with specific washing agents.

Roller covers must be compatible for the ink type, coating and cleaning agents used – if not, the blankets and rollers will swell causing a rapid decline in quality, productivity and replacement cycle.
Photo: Westland.

Compatible performance requires incompatible chemistry! Substances harmful to rubber migrate from cleaners, solvents and ink additives causing either swelling or shrinking. Incompatible polarity of materials has a very significant effect on migration and swelling. Ensuring opposite polarities of the ink system and the rubbers used for rollers and blankets is the key to their resistance:

- Conventional oil-based inks and washes are non-polar and are used with standard polar blankets and rollers (mainly nitrile polymers).
- UV inks and washes are polar and require rollers and blankets to be made from non-polar rubber materials (EPDM or butyl).
- Cleaning agents are the most critical part of the system and must be compatible.

Rollers

Ink roller covers

Selection is related to the production ratio between printing of full UV, UV hybrid and conventional inks. Full UV and conventional inks:

- < 20% UV production – use standard NBR (soft) covers provided that the rollers are initially run-in with mineral oil-based ink. The rollers will swell when using UV ink but the swelling reduces after changing back to conventional inks
- 20-99% UV production – use special combi covers with an NBR base and additives to prevent swelling when running UV.
- 100% UV production – only use EPDM covers with UV inks and washing agents because they interact rapidly and negatively to even small amounts of conventional chemistry.

In a mixed process, standard NBR shows more swelling with UV inks and more shrinking with conventional inks than combi material. This means roller adjustment must be controlled more often.

UV hybrid and conventional inks

UV hybrid inks from different suppliers can have variable interactions with different kinds of rubber. Some hybrid inks can slightly extract the combi rubber (removing its softener or plasticiser causing roller shrinking) and have no reaction with standard NBR, others may have a slight swelling reaction with the standard NBR. above this level presses should be equipped with combi rollers.

Guidelines:

- Hybrid ink rollers must first be "run-in" with conventional inks before using them with UV (if not swelling is irreversible).
- Frequent printing with conventional inks is essential to provide a recovery period to reduce the swelling trend.
- < 30-40% UV hybrid production – use standard NBR (soft) covers. The rollers will swell when using UV ink but this reduces after changing back to conventional inks

• 30/40% - 100% > UV production – use special combi covers with an NBR base and additives to prevent swelling when running UV.

Dampening rollers

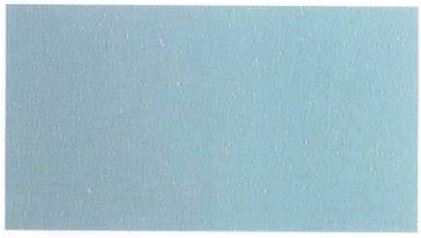
UV ink cannot handle as much water as conventional ink and its ink/water balance sensitivity is higher – therefore, dampening volume should be reduced. Equipment of the dampening unit is also dependent on the UV ratio.

• Less than 20% UV share: dampening unit remains equipped for conventional printing, above this level combi rollers should be used for UV hybrid.

• Above 30% UV share: the forme damper should be covered with combi material (special NBR) and the metering roller covered with combi material because it is cleaned with UV washing agents. This provides a better water transmission and a longer service life. In all cases, use Combi NBR with 30°Shore A for the metering roller to help ensure good water supply to the printing plate.

If the UV washing agent is applied through the metering roller, the system will require thorough cleaning when changing inks. Uneven swelling of conventional dampening rollers leads to emulsification and more frequent washing – a special NBR combi compound for UV is available from some manufacturers.

Equipment for low/no-alcohol printing can be used with both ink systems. Contact the roller manufacturer to ensure chemical compatibility. Temperature control becomes more important when printing alcohol-free; contact the press manufacturer to help optimise alcohol-free printing.



These two photographs show the compatibility and non-compatibility between the top rubber layer of the blanket and UV inks. Photos Reeves.

Blankets

Performance in UV printing is influenced by blanket fabric quality, compressible layer, load development and surface finish. The key factor is the top rubber compound of the printing face, which requires good chemical stability without swelling when using UV inks. A nitrile top rubber compound can behave in a different way to EPDM or butyl top compound, which is why laboratory tests are needed to assess the top face of a dedicated UV blanket with common UV inks. UV blankets are available as 3-ply blankets with 1,70 mm nominal thickness and 4-ply blankets with 1,96 mm nominal thickness.

Blanket choice is determined by the type of ink and coatings to be used:

Ink & coating type		Recommended blanket type
Pure UV ink only	➢	Dedicated UV blanket
UV and Conventional inks	➢	Combi blanket
UV Hybrid ink	➢	Combi or standard blanket
Conventional inks plus UV coating	➢	Standard and strippable/coating blanket

Standard blankets are mainly manufactured with nitrile polymers that contain polar units and are used for non-polar oil based inks and washes – these chemicals will not dissolve or swell the blanket. Some standard blankets can be used for both conventional and UV inks on the same press.

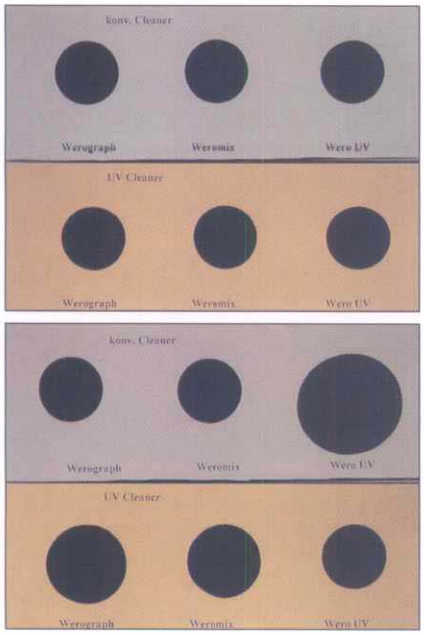
If UV use is high, the lifetime of a standard blanket becomes shorter and is subject to swelling or bad print quality after a limited number of copies. Polar chemicals have a devastating effect on a polar nitrile blanket.

A specialised UV blanket (with a face made from non-polar rubber EPDM or butyl) is needed when a large proportion of production is with UV inks. These are resistant to attack from polar solvents and inks.

These blankets can be severely damaged by non-polar solvents.

Water solvent protection of blanket fabrics protects them against penetration by solvents, additives and other chemicals. Photos Reeves.

Cleaning agents



Materials compatibility is demonstrated by a simple test using samples of three different roller rubber compositions and dipping them into a conventional ink cleaning agent and into a UV ink cleaning agent for 20 minutes. The NBR sample shows no visible reaction from the conventional washing agent but increased size significantly (swelling) when exposed to UV washing agent. EPDM exposed to conventional washing agent significantly increases its volume within a short time (swelling)but has excellent resistance against the polar UV cleaner. (Source: Westland).

The simple experiment shows the different polarities of a UV cleaner and a conventional cleaner. In spite of intensive shaking they will not mix together and a clear phase break will always take place. Source: Westland

Different inks require different washing solutions with adapted binders. Cleaning agents and chemicals for rollers, blankets and coating plates need to:

- Be chemically compatible.
- Conform to environmental and toxic standards.
- Clean effectively.

It is also important to select the correct washing programme and cycle time for the combination of materials being used (substrate, ink, blanket and roller coverings), the washing system (brush or cloth) and type of washing agent.

There are currently no international standards for these products; therefore, consult your ink supplier for their recommendations. A European agreement between press manufacturers, associations and the FOGRA Institute aims to encourage the use of washing solutions that have a low environmental and health risk as well as good compatibility with the printing press (rollers, pipes, seals and paint) and could lead to regulations similar to a standard. The cleaning agents that are recommended after a successful FOGRA assessment get a test certificate. For a list of tested products consult www.fogra.org.

Printers running standard 4-colour ink set with few changes often find that one cleaner for the combined process will be sufficient. However, with a wide variety of inks and frequent changes, some printers have two tanks – one for blanket cleaner and one for roller cleaner. Two additional tanks can be useful when running a 50/50 combined process for separate UV and conventional blanket and roller washing solutions.

Comparative washing agent efficiency

Findings from comparative washing agent efficiency tests show that agents for conventional inks provide excellent results and satisfactory to good results for UV. The tested UV hybrid washing agents only achieved poor to just satisfactory results – however ongoing development of washes for these inks might improve performance.

Summary of test results:

- **Conventional inks**–generally one wash is sufficient for good results using washing devices with most commonly-used washing agents.
- **UV inks**–can be washed up quickly and effectively using the appropriate UV washing agents; combination washing agents also give good results with UV inks in washing devices with only one wash.
- **Hybrid inks**– cannot be washed with any available conventional hydrocarbon-based washing agent – neither in the blanket nor the inking roller washing devices. Results with combination and UV agents in the blanket washing device are only just satisfactory, but unsatisfactory in the inking roller washing device (two wash-ups were needed and the scraper blade had to be cleaned between programmes because of the ink high tack). Not even aggressive, aromatic-based agents (used in the USA) prevented a manual intermediate wash-up. A vegetable oil derivate (bio washing agent) produced satisfactory results without intermediate washing when the amount of washing agent was increased by 25%.

UV hybrid inks are relatively young technologies that have significant differences in their ink ingredients and qualities, particularly between Europe and the USA. Therefore, follow the advice of your ink, roller and press supplier on what is appropriate to use. If in doubt, test before use.

	Blanket cylinder washing device			Ink roller washing device		
Ink type	**Conventional**	**UV ink**	**UV hybrid**	**Conventional**	**UV ink**	**UV hybrid**
Washing agent						
Conventional	••••	••	•	••••	•	•
Combi type 1	••••	••••	•••	••••	•••	•••
Combi type 2	•••	•	•••	•••	••	•••
UV type 1		•••	••		•••	••
UV type 2		••••	•••		•••	•••
Vegetable oil derivative type 1	••••		•••	•••••		•
Vegetable oil derivative type 2	••••		•••	•••••		•
Vegetable oil derivative type 3			•••	•••••		•••

Comparative performance: Very good •••••, Good ••••, Satisfactory •••, Poor ••, Very poor •
Source: MAN Roland Expressis Technics N° 12.

Storage and handling of UV consumables

Consumable materials	Storage conditions							
	Storage position	Keep in packaging	Sensitive to sun light	Sensitive to Artificial light	Sensitive to ozone	Max storage time/months	Temperature °C	Humidity % RH
Plates	On pallet	•	•	•		6	20-25	50-55
Paper	On pallet	•	•			6	20-25	45-60
UV inks	Closed container	•	•	•		12+	5-25	
UV coatings	Closed container	•				12+	5-25	
Blankets	Flat < 14-high	Unroll	•		•	12	20 +/- 5	50-65
Rollers	Verti./Horiz.	•	•		•	12+	20 +/- 5	
Chemicals	Vertical	•	•		•	3-6	20 +/- 5	

⚠ *Avoid storing consumables near electric motors and cabinets that produce ozone and can cause deterioration.*
Storage area should be ventilated and consumables should be kept out of direct sunlight.

Inks and coatings

To prevent premature polymerisation of UV inks and coatings, do not expose them to direct sunlight when in open buckets, ink ducts and rollers. Premature ink polymerisation can occur under levels of high heat and shear. If UV inks or coatings are pumped to ducts, all seals joints and hoses should be opaque and resistant to UV chemistry (PTFE is widely used for seals together with stainless steel piping) except if non-contact pumps are used.

There is a high variation of storage time between UV inks and coatings; therefore, consult your supplier for storage duration. Storage of coatings under 10°C may cause crystallisation. Do not exceed 30°C.

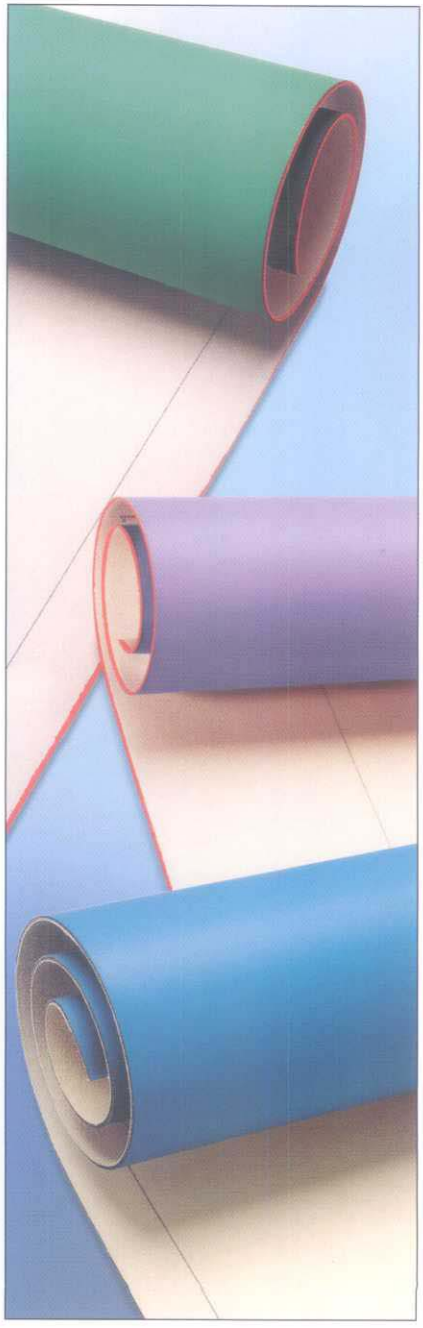
Uncontaminated press returns can be stored under the same conditions as unopened inks and should be reused within three months of being returned to stock.

Blankets

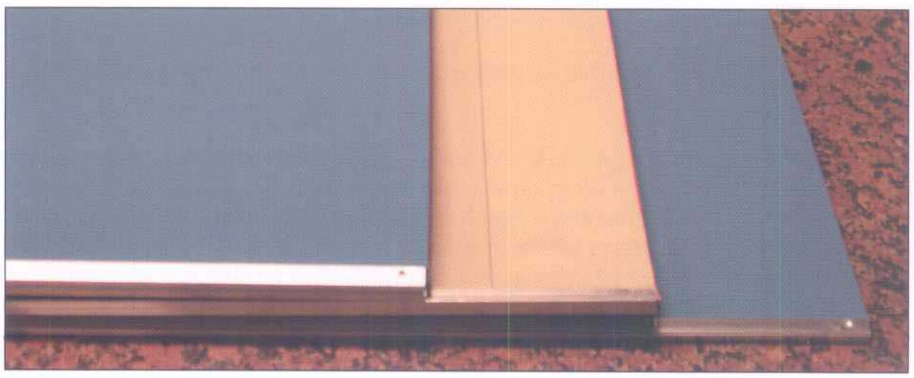
Must be unrolled immediately on delivery and stored flat face-to-face to avoid surface damage. Stack no more than 14 in a pile otherwise their weight will permanently distort blankets at the bottom of the pile.

Ink rollers

Leave them in their wrapping and store them in adapted racks to avoid any surface pressure on the roller cover.



Blankets should be immediately unrolled on delivery and stored flat face-to-face. Photo Reeves



2 Best practice operation

High production quality and productivity requires that the total process is treated as an integrated production system. This includes optimising the use of all consumable materials and continues with adapted pre-press, systematic maintenance, correct equipment settings and best practice operation.

Safety, Health and Environment

Best practice starts with knowing and following safety, health and environmental recommendations and regulations. The following are a selection of basic recommendations. However, local laws and regulations should always be given precedence. There is an increasingly regional approach in Europe with a common approach by organisations such as HSE (UK), CNAMTS (France) and BGDP in Germany.

Safety:

- Detailed information is given on material safety data sheets provided by consumable suppliers. Always refer to these before using any product.
- Follow the safety, operating and maintenance procedures recommended by equipment suppliers.
- Energy curing products are eye irritants; so protective eyewear should be worn during dispensing.
- Never look directly at UV radiation or enter into a radiation zone.
- Never mix cleaning cloths for conventional and UV inks into the same bin. This can lead to cross contamination and make disposal unnecessarily complicated.

Materials handling: Energy curing products can be handled in a similar way to oil-based and water-based products while observing the same high standards of hygiene and working practice. See page 21 for materials storage.

Health: Suitable protective gloves should be worn during wash-up, especially if using solvent-based washes. Contaminated clothing should be removed and properly laundered before reuse.

Spills & Cleaning: Spills should be cleaned up immediately because energy curing products do not dry; if spilled they can easily be spread around the workplace creating a safety hazard.

First aid: In the case of accidental skin contact, the skin should be washed thoroughly with soap and water. Solvent-based washes should not be used to wash skin (they remove natural protective oils and so increase the risk of dermal absorption of energy curing products).

Environment: Energy curing has been designated the best available control technology to reduce atmospheric solvent emissions.

Waste wet ink & coating disposal: All inks are classified as 'controlled waste'. Energy curing products are considered as hazardous waste because they contain irritants to the skin and eye; and some ingredients are harmful to the environment. However, energy curing products are not considered corrosive, explosive, flammable or toxic to human health so they can be land-filled – taking into account local regulations. The best option for the disposal of wet energy curing products is controlled incineration.

Recycling: Waste material printed with UV inks can be recycled using existing techniques.

Operating environment

For optimum results, the press room temperature should be 20-30°C with a relative humidity of 50-60%. The environment should be as dust-and draught-free as possible. Production and quality performance will decline if these conditions are not maintained.

Key maintenance issues (different to those of conventional offset).

Dampening system maintenance: Due to high sensitivity of the UV ink/water balance it is essential to maintain the system frequently and thoroughly. FOGRA recommend a specific test plate for controlling and adjusting the dampening system on the press.

Cleanliness: Hygiene during coating changeover is very important to ensure high and stable quality. The press must be cleaned thoroughly when changing from conventional to UV inks, and vice versa, because of the chemical differences between these ink systems.

Ink mist: Caused by the fast revolution of ink rollers with highly viscous inks. The ink mist must be exhausted because it is a health hazard and contaminates the inking unit. When exposed to UV light (or daylight over a long period of time) the ink becomes cured and is difficult to remove. Minimise misting by reducing the dampening solution volume to the absolute minimum level.

Ink roller settings: These need to be monitored more frequently for mixed conventional and UV operation because of the risk of swelling.
- Rollers for UV printing should be set with a minimum bounce to the plate to avoid scum lines.
- Ink rollers for UV should be set 20-25% less than for conventional inks.

Dryer: Good curing production quality, productivity and lamp life are dependent upon system maintenance, cleanliness and temperature stability.
- Regularly check that water pipes are not restricted by build-up of scale; and clean air filters to ensure adequate airflow to maintain cooling efficiency.
- Clean dryer at regular intervals.
- Use soft tissues with alcohol to clean lamps and reflectors. Do not touch the quartz bulb with bare hands as traces of grease or dirt will burn on to the lamp and reduce its efficiency.
- Routinely test lamp status (e.g; Green Detex method of UV light sensitive tape).
- Change UV lamps as required. The normal lifetime is 1 000 - 1 500 hours depending on the mix of jobs and lamp cleanliness.
- The time needed to change a lamp is about five minutes per module – once the lamp has cooled down and the machine panels are removed.
- Change reflector, usually between 5 000 - 10 000 operating hours.

Lubrication: Use only heat-resistant grease.

Dampening system maintenance

Daily :
- *Check temperature, conductivity, pH value and alcohol content.*

Weekly:
- *Clean solution tanks and pans for optimum water receptivity*
- *Drain system pans, lines and tanks. Refill with hot water.*
- *Add prepared fount system cleaner, and pump into pans to circulate.*
- *Maintain cleaning solution flow through system until only discoloration of the solution is visible and no large particles are left.*
- *When system is clean, drain, flush with clean water, drain, and wipe out pans and tanks.*
- *Change all filters before refilling with fountain solution.*
- *Before fountain solution is pumped into pans clean all damper rollers and etched chrome rollers.*
- *Desensitise roller surfaces by cleaning and etching them (rubber, chrome and ceramic rollers).*
- *Inspect system for bacteria growth.*

Refresh dampening water:
- ***every 2 weeks for alcohol-free solutions ;***
- ***every 4 weeks for IPA alcohol solutions.***

Annual maintenance :
- *Empty the dampening system and remove all filters.*
- *Sufficiently fill the reservoir with cleaning solution to ensure a smooth circulation.*
- *Circulate 2 to 3 hours. (Turn off freezer unit and run warm whilst cleaning).*
- *Empty the reservoir and rinse with water for at least 10 minutes.*
- *Re-empty the reservoir and rinse with water and 2,5% of fount additive.*
- *Empty the reservoir and re-fill with dampening water, ready for use.*

Prepress

Reproduction

UV inks have a higher dot gain (spread) than conventional inks. However, this can be compensated in pre-press by adjusting plate setter calibration curves.

UCR (Under Colour Removal) should be used during pre-press to minimise ink film weight and consequently minimises dampening quantity – this has a significant affect on maximum printing speed.

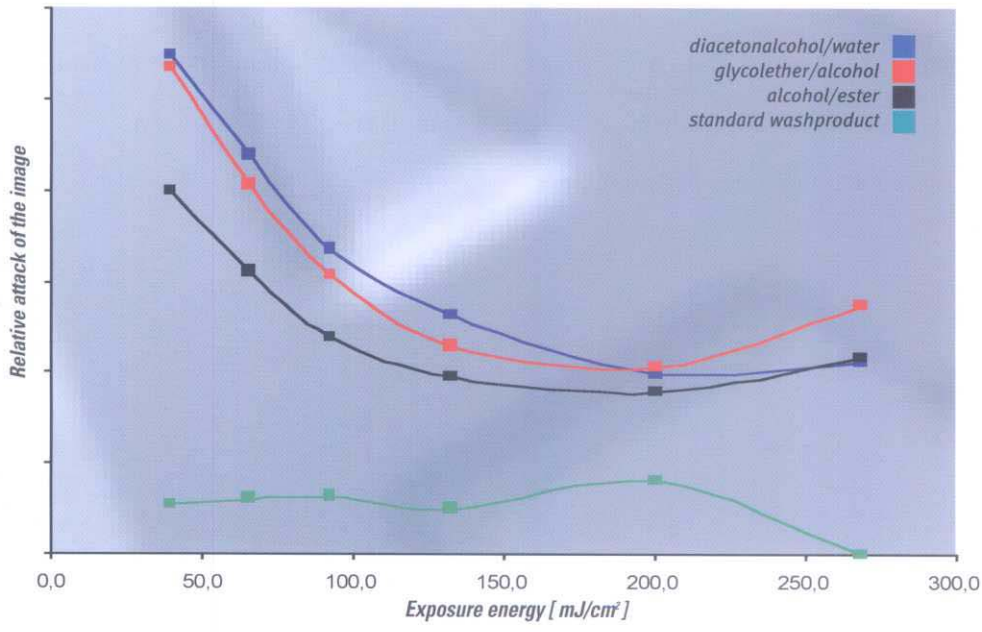
Plates for UV printing

UV inks take up less water and consume less fountain solution than conventional inks. A plate's aluminum substrate, graining and anodizing all have an influence on the ink/water balance. In general:

- Negative plates are more stable than unbaked positive plates.
- Baking improves the run length stability of negative plates based on photopolymer technology and positive plates based on diazo resin technology.
- Special positive plates for UV printing are available for printing short runs without baking.
- CtPlates based on silver halide technology, photopolymer and thermal also perform very well with a lot of ink/fountain combinations.

Improving plate run length

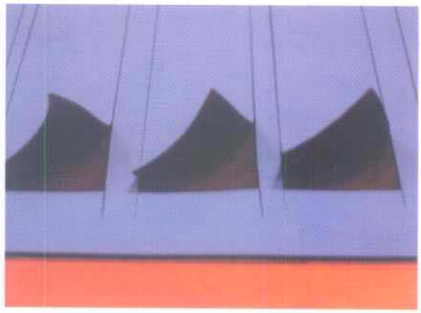
- Ensure chemical compatibility of plates with UV inks, washes and cleaners. (see drop test page 13).
- The wear resistance of the image areas of negative plates depends on the exposure energy – the higher the energy, the better the resistance.
- Baking negative working photopolymer plates doubles their run length stability. Baking positive plates results in UV run lengths equal to conventional inks – it also provides excellent chemical resistance. However, baking adds a step to plate making and it must be assessed against the additional investment, energy and floor space required.

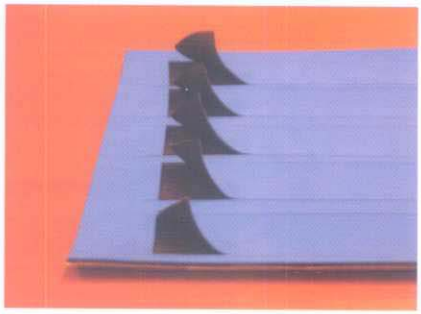


Resistance of negative plates (image-parts) depends on the exposure energy – the higher the energy the better the resistance. Source Agfa.

Coating image carriers

Selection of the coating and its image carrier (blanket or photopolymer plate) depends upon the application: (1) Flood, the overall coating of a full sheet, (2) Knock-out of simple non-coated areas (glue flaps, book spines and ink-jet address panels) or (3) Spot coating to selected areas with precise registration. See page 14.





Strippable blanket with top face stripped from the open cell compressible layer. Photo Reeves.

Stripping blanket: For flood and knock-out coating.

- The blanket is mounted directly on to the cylinder and the image is printed on to it. It can then be either stripped on the cylinder or off press on a table. Carefully strip with a knife ensuring not to cut through the total thickness (or coating will penetrate the blanket and will reduce its dimensional stability).
- After stripping remove any threads left after the cut to avoid coating build-up.
- Compared to a polymer plate slightly higher pressure is required for an optimum coating transfer. Depending upon the cylinder undercut, some hard or soft packing may be needed.
- During production the blanket carcass becomes soaked with coating and will lose its dimensional stability. Therefore, to ensure register on repeat jobs it is recommended to make a new stripping blanket.

⚠ Elastomers have an affinity with oil-based ink but not with water-based or UV coatings. Therefore, the quantity of coating transferred and gloss is generally inferior to polymer plate.

Pre-cured polymer plates: Used for flood, knock-out, and spot.

- The polymer plate can only be processed out of the press; therefore, the image distortion factor (anamorphosis) must be taken into account, but the process is quite simple and does not require any special equipment or knowledge. Manual preparation types have a water-washable diazo top coating that can be developed using standard negative film in a conventional exposure unit. Once exposed, the non-coating areas can be easily identified.
- After washing and drying a special cutter and a metal rule is used to prepare image area. It is important not to cut or damage the PES base. Attention: the plate can be damaged from cracking at the bend before going in to the cylinder gap.
- Polymer plates are not compressible but can deform. Use a compressible underpacking to provide more pressure latitude and improve coating transport. A nip pressure strip of 6-9 mm is recommended.

Plastic film with sticky backing: For knock-outs.

- Ensure plate is completely degreased and apply film carefully to avoid creating air bubbles.

Remove the non-coating areas after cutting and fit the plate on to the cylinder.

- Before coating, it is recommended to set the "put impression" to 'on' (is this what you mean?) in order to obtain complete adhesion of the film on to the plate.

Photopolymer plate: Precision spot and knock-out coating.

- Solvent washable flexo plates are recommended for UV coating.
- Correct pressure setting is important, because wear is the most frequent cause of plate damage. Pressure should be set to match print conditions (substrates, anilox roller). Soft underpacking is recommended for consistent and even coating transfer.

Inks & Coatings

Inks

Combination presses: UV and conventional inks are totally incompatible and should never be mixed. Double wash rollers when changing from one ink system to another.

Cool weather: A UV reducer can lower ink tack and improve flow. Use only 1% at a time in carefully measured doses to ensure that curing performance is not affected. Overcome low temperature start-up by running the press with impression 'off' to pre-heat ink rollers.

Metallic inks:

- For frequent use of gold (bronze) and silver (aluminium) pigments use combi rollers on the printing unit.
- Some UV metallic inks contain low molecular components with a very low polarity that may cause swellings of EPDM roller covers; consult your ink supplier.
- Metallic particles in UV ink tend to reflect radiation, causing poor curing that leads to blanket build-up and more frequent cleaning. For this reason, some printers prefer to print conventional metallic inks on top of inter-deck cured UV inks to avoid trapping problems.
- Metallic and white inks tend to print better with a long ink path through the roller train. On some press types it is possible to lengthen the ink path and reduce water feedback into the ink duct by removing a roller. Attention: this may increase risk of ghosting.

Coating application

Gloss level is dependent on the substrate coating, ink coverage (the higher the ink film thickness and coverage, the lower the obtainable gloss), printing speed, the drying/curing system, coating method (and roller type), the coating substance, the temperature of the coating and the substrate. High gloss UV coatings require high carrying capacities for both flood or spot coating.

Optimise the coating and film weight for each substrate for the best cost-to-gloss performance (excessive film weight can cause insufficient flexibility and if folded may have poor adhesion in the folded areas; it is also uneconomic.) Only apply the film weight necessary for maximum gloss and mechanical resistance. Exceeding this level gives little or no increase in gloss.

Variations in the level of gloss are particularly noticeable on large flood coated areas; therefore, coating must be applied very evenly to ensure uniform gloss across the entire image.

Conventional inks + Primer + UV coating

- Ink composition and its affinity to the primer determine the bonding of the coating layer, which only becomes definitely stable several days after printing.
- Print with as little water as possible to minimise blanket ink build-up and reduce the risk of mottling. If very fast-absorption inks are used in the first printing units, then ink splitting on the blankets in the subsequent printing units may cause mottling.
- Use specially adapted inks to avoid risk of colour change when applying UV coating over conventional inks that contain non-solvent proof pigments (HKS 13, 25, 33, 43, PMS warm red, rhodamine red, purple, blue 072, reflex blue).

Gloss withdrawal is a negative interaction between ink and coating layers that affects gloss some time after the job is finished (see panel).

UV coatings + UV inks

These produce the highest gloss results with minimal change during the curing process. Increasing the amount of UV coating applied can improve gloss level.

- Optimum gloss results require foam-free coatings – otherwise spots may appear on the finished surface. Spills into the press can be caused by foaming, leading to additional cleaning time. Minimise this by ensuring the coating system does not become too agitated (entraining too much air). Foaming often causes poor supply return and can increase the level of coating in the pan. Use de-foaming agents.
- Good coating flow becomes more difficult when applying high volumes (depending on viscosity). Heating the coating to 40°C has a positive effect on flow properties and this can also increase gloss.

• The geometry of the anilox screen rollers strongly influences coating flow.

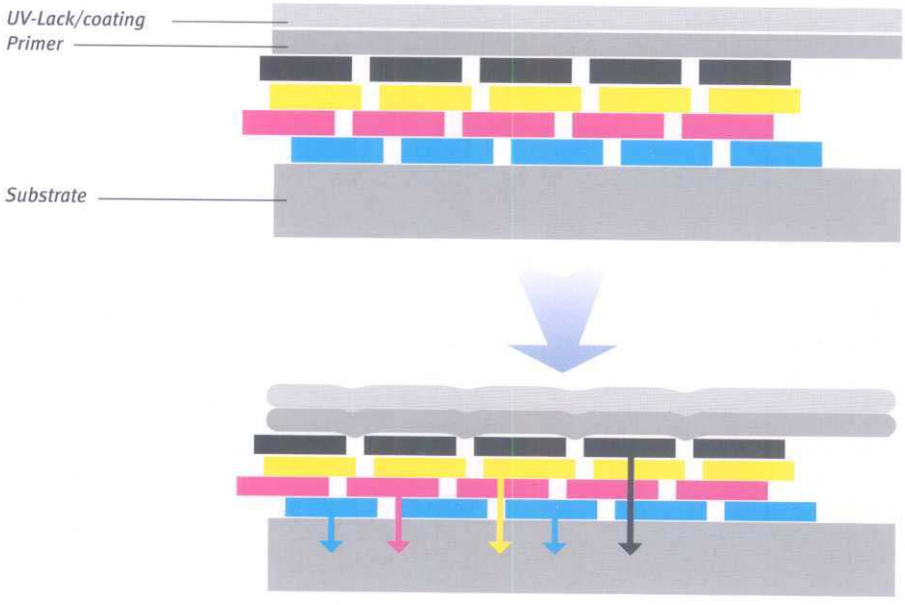
Off-line UV coating

UV coating over dry conventional inks can lead to trapping difficulties. Lack of adhesion of the dried coating may result in orange peel effect or crater formation. Ensuring the right combination of materials throughout the production chain will avoid or minimise this risk.

- Too much spray powder negatively affects adhesion – use only the minimum quantity on an uncoated grade.
- Minimise excessive ink film weights and multi-colour builds that can cause excessive accumulation of ink distillates and additives at the ink surface during drying and which also reduces surface tension.
- Conventional inks must be completely dry prior to coating (minimum delay is about 48 hours).
- Avoid a long delay between printing and coating. After 72 hours, there is a risk of poor adhesion due to surface crystallisation and hardening with reduced surface tension.
- Apply the optimum coating film weight for maximum gloss and mechanical resistance.
- To avoid discolouration clean thoroughly when changing from pigmented coating to clear coating.

Oxygen inhibition: This mainly occurs with low-viscosity UV coatings. It shows up after hardening in the form of a greasy film on the coating surface – when this film is wiped off, the coating surface below is glossy. The cause is high levels of oxygen that enter the coating and diffuse into its surface. The solution is high intensity curing to rapidly seal the ink surface to minimise oxygen entry.

Gloss withdrawal (dryback). The negative interaction between ink and coating layers, which can affect gloss some time after the job is finished. This is caused when oxidation drying of conventional inks and the primer continues under the cured UV coating, leading to differential gloss between printed and non-printed areas, less gloss and poor adhesion. The effect can be seen in the double coating process and occurs mainly when printing substrates with high or medium recycling content along with high ink area coverage (>200%) and when UV coating is applied over a primer. The gloss level can decrease by several points in areas with high area coverage. There are different proposed explanations for the effect: one is that in areas with high area coverage the inks absorb into the substrate immediately and in other cases take minutes or hours to dry. Both lead to a loss of volume in the ink that causes the layers of primer and UV coating on top of it to collapse. This changes the light refractions on the UV coating surface and results in lower gloss.



The volume of primer applied over conventional inks has an influence on the final gloss level of the UV coating. Source: MAN Roland.

Printing

The three absolute priorities for high quality and productivity are:

- Chemical compatibility of all the consumables in the process system with inks and coatings matched to the substrate, finishing and end use.
- Correct press and dryer settings and the production line regularly cleaned and maintained.
- The key to efficient UV printing is to keep dampening water to a minimum to obtain maximum production speed.

Printing blankets

Products	Polars	Non-polar
Blanket face	Nitrile rubber	EPDM-BUTYL
Ink vehicule	Acrylate oligomers	Mineral or Soyabean oils
Blanket wash	Alcohols, Ketones (MEK, acetone), Esters (Ethyl acetate), Ethers	Mineral spirits, VM & P naphta, Tolunes, Xylene, Carbon Tet

It is essential to ensure correct compatibility of polar and non-polar UV blankets, inks and washing agents. (See also page 18-20.) For each blanket type a specific washing agent is required, otherwise blankets will be severely damaged.

Some common blanket issues

Ghosting – when the black text of the previous job is visible in the screen areas when switching to a new job. This may be caused by blanket swelling from using a blanket incompatible with the UV ink (or washing solution).

Use appropriate blankets with a top face compatible for UV inks and clean with correct washing agents.

Swelling on standard blankets when UV and conventional inks are used on the same press is caused by the incompatibility between the washing agent and blanket face.

Use the correct solvent to clean the blanket without swelling the top face; use combi materials.

Blanket delamination can be caused by swelling over the whole surface that generates too high indentation and friction.

Ensure compatibility between blanket, inks and washing agents; or consider using combi blankets.

No special care is needed to handle or mount UV blankets on the press.

Follow the supplier's instructions to store, tension and clean correctly. Use only appropriate chemicals.

Press rollers

The choice of rubber roller compound is simple for presses that run only conventional (NBR) or UV inks (EPDM). However, running UV and conventional inks on the same press is more difficult. The performance characteristics of rollers for each ink application are variable. Source Westland.

Caracteristics / Material Process	EPDM 100% UV	Standard NBR Conventional	Combi NBR Combined
Extraction resistance	•••••	•••••	••••
Elasticity	•••••	•••••	••••
Rebound at the gap	•••••	•••••	•••••
High stability with conventional inks	•	•••••	••••
High stability with UV inks	•••••	••	••••
Low heat build-up	•••••	••••	•••
Ink-water balance	•••••	•••••	•••••
Longevity	•••••	•••••	•••••

Comparative performance: Very good •••••, Good ••••, Satisfactory •••, Poor ••, Very poor •

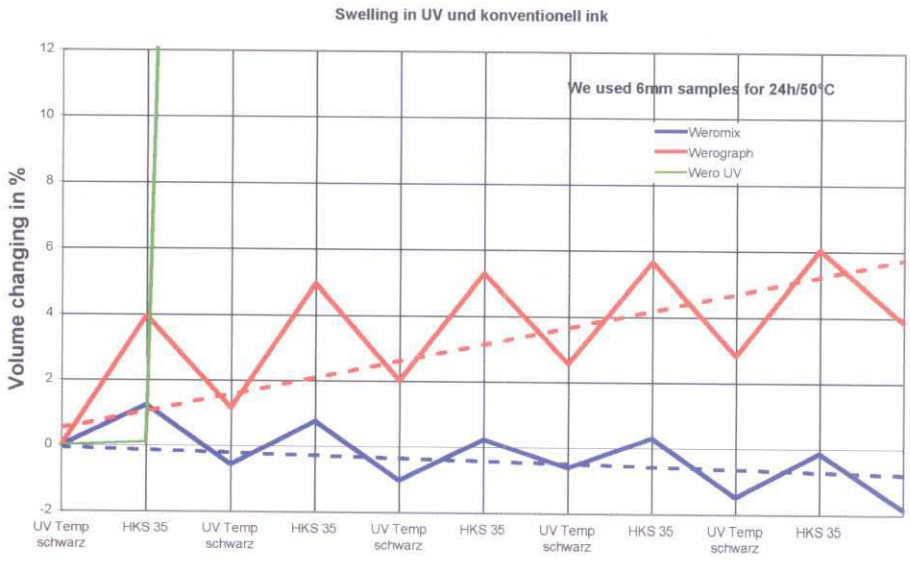
For any combination of inks there is an optimal roller covering solution and washing agent. See also pages 18 and 20.

The consequences of an unfavourable materials combination includes swelling that can impair the function of the rollers so badly that printing cannot continue.

The cleaner and the solvents for the ink systems are critical to the performance of the rubber compound. Different ink system and rubber rollerpolarity is the key to the resistance of the rubber roller. Ask your ink and washing agent suppliers for information on compatibility of their products with NBR, Combi NBR and EPDM rollers.

Best practice for ink and dampening rollers

- Rollers for UV printing should be set with a minimum of bounce to the plate to avoid scum lines.
- Ink rollers for UV should be set 20-25% less than for conventional inks.
- There is a link between the ink axial oscillation movement and printing problems of ghosting and dot gain. If ghosting is a problem, then oscillation may be too low; however, increasing oscillation may increase dot gain – and vice versa – therefore, the goal is to find the right balance.
- Clean rollers regularly with an adapted washing agent to maintain their settings longer and extend the life of the coverings.
- In mixed production with under 20% UV proportion, use standard NBR and condition new rollers with conventional inks during the first weeks.
- In mixed UV/conventional production, regularly monitor and adjust the setting of the throw-on of rollers.
- For over 20% UV, use combi material for both ink and dampening rollers.
- For 100% UV, use EPDM in the ink unit with combi rollers in the dampening unit.
- If metallic ink pigments are used frequently on the same print unit, equip it with combi rollers – even if the press runs 100% UV. For many inks non-polar oils protect the metallic pigment against corrosion – which can affect EPDM covered rollers.



This chart shows the swelling effect when alternatively printing for 24 h with UV ink and 24 h with a conventional ink on conventional NBR (WEROGRAPH) and combi (WEROMIX) rollers. With UV ink swelling occurs, but is less with combi rollers; with conventional ink extraction occurs; the swelling and extraction of both inks partly compensate each other. Severe production problems occur if rollers swell over 10% of their volume. Source Westland.

Press operation

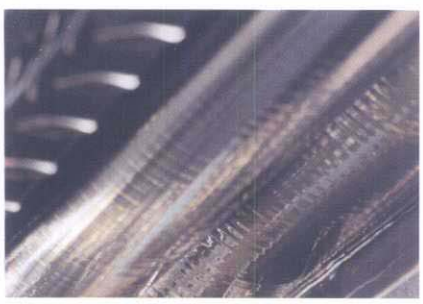
Some additional skills are required for printing with UV inks as their properties and drying behaviour are fundamentally different from conventional inks.

Minimum dampening is essential!

UV systems need much less dampening than conventional inks. UV inks with too much water cause ink misting that creates many running problems – a 'dryer' ink train allows faster printing without ink misting.
Minimum dampening is the prerequisite to obtain maximum production speed, reduce ink misting, and avoid emulsification with low ink coverage.

- Ensure dampening is set just above the point of ink catch-up on the plate, but always with ink marking on the plate's leading edge.
- If the potentiometer speed is 70% for conventional inks, a UV job should be started with 40%. The running free point of 55% is much easier to reach by increasing the water. With conventional inks the speed of the dampening unit can be decreased to achieve the correct ink/water balance, but this is nearly impossible with UV ink because it stores the water (and leads to further problems).
- If there is still too much water (or ink wash-out) when printing with the lowest dampening unit potentiometer speed, then reduce the nip setting between ceramic duct and water forme roller to reduce water to the plate. (This nip has the highest influence to regulate the dampening unit speed range and it reacts differently to all other nips in the press. The forme damper runs with the same speed as the plate but the ceramic and the metering rollers are nearly four times slower causing the plate damper to rub the water from the ceramic roller. A narrower nip reduces water transfer to the plate damper and the ceramic roller must run faster to deliver enough water for the running free point.) Make the opposite adjustment if the speed is too high (over 90%) and increase the nip setting to increase water carried by the plate damper.
- Too great a speed difference between pre-dampening and normal dampening leads to too much water and increases printing waste. Either reduce the pre-dampening speed or increase the ground speed of the dampening unit (by reducing the nip between ceramic and plate damper).
- UCR (Under Colour Removal) should be used during pre-press to minimise ink film weight and consequently minimise dampening quantity.
- The dampening solution must be carefully metered and the system perfectly maintained.

Printers running their first UV jobs often set the water much too high leading to over emulsification, water marks, toning in the ink free areas and ink misting. The only solution is to stop the press and wash the ink unit.



Improving UV production

Spray powder should not normally be used because it migrates to the UV lamp surfaces and reduces their power output, lowering their curing efficiency and operating life.

Piling when printing UV? If the curing is too hard, the ink becomes brittle and piles on the blanket one or two units later.

Reduce the UV power on the unit where piling originates. Slightly increase water in the unit where ink is piling to decrease ink hardening (but ensure that the leading edge of the plate is still inked). Switch on the blowing device to avoid emulsion problems.

Tinting in the UV process is a severe constraint with regard to decreasing alcohol content. Tinting leads to ink build-up on the non-printing area of the blanket and impression cylinder. The cured hardened UV ink deposit is difficult to clean and the build-up can change the pressure between impression and blanket cylinders.

Absolutely avoid over-emulsion of the ink unit. There is less tinting with alcohol. Ask your supplier for an improved fountain solution. If possible, avoid curing with the inter-deck; if this is not possible, then try to improve the shadow to the blanket cylinders

Improving combined printing process with low alcohol.

Use a good fountain solution and alcohol reduced to 5% with water temperature maintained at 16°C. Use the blowing device when necessary. Increase the ink chilling device temperature to 2°C above the condensation point on the ink duct (around 23°C).

Improving UV printing at high speeds.

Absolutely minimise the water in the ink unit (but ensure that the leading edge of the plate is still inked). Increase ink chilling device temperature to 2°C above the condensation point on the ink duct (around 23°C). Use the blowing device when necessary to avoid emulsion problems and ensure efficient exhaust operation. Optimise the consumables (rollers and blankets) consistent with the proportion of UV production.

Curing system

Operation

- Do not touch the lamps or their housing because of their high temperature! Ensure they are adequately shielded and light tight.
- Using alcohol regularly clean dust and lint from lamps and reflectors.
- Do not allow sheets to become trapped inside lamp housings – they are a fire hazard.
- Maximise lamp life by avoiding unnecessary press stops and starts as this reduces lamp life. When starting a new job, first run some sheets through to verify smooth sheet travel and delivery; only then switch on the lamps.

Use the correct procedure to maximise productivity and avoid inadequate curing of UV inks and coatings:

- Correctly match press speed and lamp power because ink and coating curing resistance is directly related to UV exposure. Because of the many different types of lamps available, there are no general rules; therefore, contact the supplier for the correct speed/lamp power for your configuration. Running at too high a speed with underpowered lamps will lead to inadequate energy available to cure the ink or coating.
- Optimise ink and coating film weight to the lowest level for good printing (this also makes economic sense). Excessive film weight will not lead to any perceptible increase in gloss but will increase the risk of ineffective curing and consequent costs.
- Lamps and reflectors need to be properly maintained and kept adequately clean to work effectively. Use an appropriate biocide to avoid biological contamination of water filtered lamps.
- When changing from one type of ink to another ensure press rollers are not contaminated and are completely clean.
- Some plastics contain plasticisers and/or anti-oxidants that can adversely affect curing or can re-soften the cured film after printing. Test them in advance of use.

Incorrect UV exposure may lead to:

- Under-cured ink that remains liquid.
- High surface tack or less durable surface.
- Partial surface cure but with poor substrate adhesion.
- Over-cured brittle surface with poor over-printing performance.
- Poor solvent or mechanical resistance, or lack of slip.
- Poor odour and/or taint.
- Poor gloss.

Causes within the UV curing system may include:

- Insufficient power supply.
- Unsuitable lamps.
- Ageing lamps.
- Excessive cooling of lamps preventing them reaching peak radiation.
- Dirty reflectors or glass covers.
- Lamps with burnt-on contamination.
- Lamps too far from substrate.
- Water-cooled lamps with incorrect or unclean water.

Causes outside of the UV curing system may include:

- Residue of washing agent in the ink system.
- Conventional ink or washing residues in the system when changing over to UV production.
- Too much reducer, varnish or water in the ink; or insufficient photo-initiators.

Post curing refers to a very slight improvement in mechanical resistance and surface 30 minutes after printing as the film 'relaxes' following shrinkage during curing. However, 'post cure' should not be relied upon and any doubt about curing should be validated by testing (see UV ink and coating testing on page 33).

At high printing speed it is more difficult for the sheet surface to be sufficiently cured and to keep heat at an acceptable level. This can result in interactions between the top and bottom sides of sheets in the delivery, leading to set-off or blocking. Poor lamp curing efficiency may result in a localised adhesion problem in areas with strong dark colours or heavy superposition that strongly absorb UV light. If the print feels soft, or the ink smears in the delivery, then stop the press to check for possible poor curing.

Tests for UV inks and coatings

⚠ **Health and Safety first:** Throughout the tests wear appropriate clothing (overalls or a laboratory coat), protective glasses and protective gloves (made of vinyl or nitryl rubber) during cleaning.

⚠ **Environment:** Ensure all waste products, solvents and cleaning materials are disposed of correctly in proper waste bins. Do not mix materials between bins and keep solvents, paper and plastic waste separate.

When is UV "dry" or "cured"?

A UV cured ink or coating is considered to be dry when it is fully fit-for-purpose with regard to print finishing and subsequent end use. There are no simple quantitative or objective tests to determine whether a UV product is 'fully cured' or not. The criterion is fitness-for-purpose.

- No build-up on subsequent blankets after UV inter-deck dryer.
- The printed product allows "reasonable" handling (slitting, folding, binding, packing, shipping and use). Excessive friction or pressure on the ink surface must be avoided in "reasonable" handling.

On some jobs there may be post curing effects where the surface takes some minutes to fully cure, but this normally has no impact on quality of stacking or set-off.

Change of colour: Coating may change the ink colour. It may be necessary to overcoat proof prints to anticipate the potential colour change.

Reflected light as a gauge for gloss: A gloss meter measures light reflected from a set angle. The angle is important because pigments that lie deeper have a scattering effect and the human eye reacts more strongly to gloss on a dark background. The angle must be constant so that the values provide reliable information on gloss variations. Different wave lengths and viewing angles are used in North America and Europe (60%).

Solvent resistance of UV ink and coating: Printed sheets can be tested to see that they have been adequately cured. The traditional method compares resistance to solvent attack between a printed sample and a standard test sample. This is a simple and effective guide that with experience is repeatable and reliable. The procedure is: 1– Place the test print and the standard on a suitable hard surface; 2– Dip a cotton bud into the test solvent until wet (inks only use Isopropanol and for UV coatings use MEK methyl ethyl ketone); 3– Rub the tip gently over both prints 20 times or until the film becomes visually damaged. The results should be recorded as (a) number of rubs to failure and (b) whether better, equal to, or worse than the control standard. FOGRA have developed a simple test device (ACET) using acetone to make this assessment easier with more reliable results under well-defined conditions.

Scratch resistance: Testing of scratch resistance and bonding properties is an important aspectin finishing operations and veritfies the durability of the printed product. The bonding of WBC primer to the UV coating layer is only stable several hours (if not days) after production as the inks dry by oxidation. This can lead to cleavage products settling between ink and coating, which spoils the bond. This this should be checked some time after the run is completed. The traditional nail and adhesive tape tests depend on the individual user's judgment. The FOGRA LHT test has mechanised the adhesive tape test to measure values automatically. The FOGRA Institute (www.fogra.org) also recommends test devices for scuff and blocking resistance. Resistance of printing can be tested in accordance with DIN 16524 and DIN 16525.

The traditional method to test if printed sheets have been adequately cured compares resistance to solvent attack between a printed sample and a standard test sample.
Source Sun Chemical.

ACET is a simple to use solvent resistance test device developped by FOGRA

FOGRA's LHT adhesive tape scratch resistance test measures values automatically.

Production diagnostics

SYMPTOMS	PRIMARY CAUSES
Tone value increase	1. The ink is absorbing too much water or the ink/water balance is incorrect. 2. Incorrect damping solution composition – check the alcohol content (7.5-8% is recommended). Experience shows that too high pH value contributes to tone value increase. 3. Ink build-up from too much water absorption (among other cause). 4. On film substrates, printing pressure is too high (max. 1/10 mm). 5. Cylinder rolling incorrect (check cylinder dressings and whether plate inking rollers and blankets are swollen). Incorrect blankets; check carcasse condition of blanket. Foil underpacking beneath the blankets might help. 6. Plate exposure/tone value curve incorrect. 7. Ink tack is incorrect leading to ink splitting problems. 8. Ink feed too high (check intensity/density). 9. Faulty curing ("blotting paper effect" on very absorbent substrates, binding agent depletion).
Ghosting	1. Poor ink distribution. 2. Pigmentation of ink is too low. 3. Ink distribution in the ink roller train not balanced (too much ink on forme rollers 3 and 4 compared to 1 and 2). 4. Check oscillation timing of ink distributors. 5. Switch on oscillation mode of ink forme rollers. 6. Rollers in poor condition.
Ink not sufficiently cured	1. Ink/water balance incorrect; or too much ink and water leading to ink film thicknesses that cannot harden. 2. Surface inhibition of lacquers. 3. Unsuitable exposure; drying disturbed by shadows (or something else). 4. Insufficient dryer output. 5. Unsuitable lamps; the lamp emission does not harmonise with the sensitivity spectrum of the photo-initiators. 6. Too-high lamp temperature shifts emitted wavelengths. 7. Over-cooled lamp reduces radiation intensity. 8. Old lamps with inadequate radiation emission. Lamps should be changed after 1 000 – 1 500 operating hours. 9. Lamps/reflectors are soiled, e.g. lamp output diminished by paper dust. 10. Printing speed too high; not enough time for the lamps to be effective. 11. The photo-initiators are not harmonised or insufficient. 12. The substrate is soiled, reactions with foreign matter on the sheet. 13. Residue of conventional binding and washing agents on the rollers Curing disturbance only occurs when printing starts and disappears very quickly if traces of conventional ink or washing agent are in the inking unit.
Ink specks on the sheet	1. Too much water. 2. Check temperature variations. 3. Incorrect ink flow.

SYMPTOMS	PRIMARY CAUSES
Inks become lighter in color	1. Insufficient ink feed. Ink gets stiff in ink fountain (solution is an ink agitator). 2. Too much water or wrong water/ink balance 3. Ink build-up on the blanket. 4. Poor ink trapping (subject accepts too little ink, inks clog). 5. Coating dissolves the ink (see magenta test); the coating slightly etches the ink films, which then slightly stains the coating.
Low rub resistance / scratch resistance	1. Films not pre-treated; insufficient surface tension prevents the ink from bonding well to the substrate. Either apply a primer or corona treatment. Surface tension on plastic film can be easily checked with a special test ink. Recommended surface tension should be 40 mN/m or, even better, 44 mN/m. 2. The ink used is unsuitable for the substrate; contact your ink supplier.
Poor ink transfer	1. Substrate surface tension is too low. 2. Pre-polymerisation of the ink, ink splitting is disturbed. 3. Ink is too tacky – see previous point. 4. Excessive washing of the rollers/blankets; washing agent residue remains on the rollers. This problem resolves itself during printing. 5. Incompatible roller covering or blanket surface. 6. Damaged rollers or blankets surfaces from incompatible washing agents. 7. Incorrect ink/water balance 8. Deposits on inking rollers due to calcium in the damping fluid.
Odour formation	1. Odour may come from the paper coating if it is sensitive to UV exposure. 2. Inks with a high percentage of low molecular binding agents and initiators tend to produce an odour.
Roller streaks	1. Plate inking rollers that are too hard; recommended roller hardness is 25° - 30° Shore. 2. The rubber rollers are too smooth. 3. The ink is accepting too much dampening solution. 4. The water feed to the printing plate is too high. 5. Check the inking and damping roller settings; set the plate inking rollers with less pressure to the distributor and the plate. 6. Ink charge is too high due to too low ink pigmentation. 7. Poor ink splitting; unfavorable ink consistency, water runs into the inking unit.
Smearing	1. Roller swelling; incorrect roller material causes dimensional change and thus changes the plate-to-inking roller contact settings. 2. Wrong washing agent can also cause roller swelling.

SYMPTOMS	PRIMARY CAUSES
	3. Washing agent in the inking unit. 4. Residue of conventional inks or washing agents. 5. The contact pressure of the plate damping rollers is too high. 6. Worn roller coverings contribute to poor water feeding. 7. Roller coverings are dirty. 8. Ink feed is too high. 9. Incorrect washing of the coverings. 10. Not enough alcohol additive in the dampening solution, which causes the surface tension of the solution to rise (7.5% is recommended).
Scumming	1. The pH value of the damping solution is incorrect (4.8 – 5.2 recommended). 2. Roller hardness and/or contact settings incorrect. 3. Plate inking rollers set too firmly to the ink distributor 4. Plate inking rollers contact setting. 5. Unsuitable dampening solution additive. 6. Printing pressure is too high. 7. Unsuitable plates. 8. Washing agent residue in the inking unit and/or dampening unit. 9. Swollen plate inking rollers impairs rolling. 10. Poorly mixed additives not spread evenly through the ink. 11. The ratio of water feed to ink feed is incorrect (as little ink and water as possible). 12. Inking unit temperature is too high causing the dampening solution to evaporate. 13. Incorrectly baked plates because gumming of the plate was not thoroughly cleaned off before exposing the plate.
Emulsification, unstable ink emulsification	1. Higher risk with black, spot colors and white. 2. Water feed is too high contributing to the damping solution "migrating" into the inking unit. 3. Unsuitable damping solution additives. Surface tension-reducing additives increase the risk of emulsification.
Unsharp print image	1. Wrong plate-blanket packing. 2. Ink too thin or too short causes poor transfer to the substrate. 3. Incorrect substrate surface tension (dot contracts or spreads on the substrate).
Uneven surface hardness	1. Soiled lamp; paper dust or similar prevents the ink film from drying evenly. 2. Too much water in the ink. Contact your ink supplier.
Blanket / roller swelling	1. Incorrect roller or blanket material. 2. Incorrect washing agent. 3. Incorrect ink.

Post-press processing

UV printing and coating allows almost immediate finishing. However, because of the wide variety of coatings available it is important to check that the product used is compatible with post-press operations and end-use.

 Always pre-test new consumables combinations for finishing compatibility.

Die-cutting & Embossing: Requires a flexible UV coating with a controlled film weight. Avoid scoring and folds in dark image areas as any scaling faults will become more visible.

Hot-foil stamping: Use a coating formulated for the purpose with optimised film-weight and curing. Ensure little or no slip agent in the coating that will impair foil keying to the surface and use only the minimum quantity of spray powder.

Folding and scoring: Good substrate adhesion is essential for maximum tensile strength for folding and scoring (avoid brittle finishes). The loss of moisture caused by heat in the UV curing process and the presence of a coating layer makes the printed product slightly harder and more brittle.

- It is important that the selected UV coating retains sufficient elasticity.
- Avoid scoring and folds in dark image areas as any scaling faults become more visible.
- Any scoring required on a job should be done after the sheets have been coated and not before.
- Scoring is strongly recommended for substrates over 150 gsm.
- Excellent condition and setting of post-press equipment is a pre-condition to process UV material.

Glueing: Applying glue over UV coating is unpredictable. Leave a coating-free strip for gluing; if this is not possible, then test the suitability of the coating and required curing conditions for the glue – conventional hot melt and EVA adhesives can be used. Check with a specialist glue supplier to get the right formulation.

Perfect bound book covers: Leave a coating-free-strip for gluing the text block to the cover.
Laser overprinting: Normally there is good adhesion of overprinting except on UV varnishes containing slip agents. However, there is a risk of build-up on the fusing roller from the high temperature – certain ink colours with low heat resistance may discolour.

Ink jet overprinting: Because these inks can be either water- or solvent-based it is extremely important to pre-test their adhesion onto a UV coating; alternatively, leave a coating-free area for overprinting. UV ink jet using digital delivery is a recent development.

Heat sealing: UV coating is generally only resistant with PP (polypropylene); do not use XS films. MAST cellophane may be suitable but should be pre-tested.

SHEETFED ACTIVITY GROUP

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Agfa is the world's number one manufacturer of leading-edge graphic communications technology. Today, Agfa combines its technical prowess with applications knowledge to bring customers complete workflow solutions from product creation to final printed product. Understanding the pressure to produce shorter print runs, faster and with higher quality, Agfa works with customers to develop the simplest, most economical pathway to process automation. The company integrates products that meet the individual demands within specific applications such as commercial printing, packaging and newspaper production. Agfa industry-leading solutions include digital proofing, PDF and JDF workflow software, CtP imaging equipment and printing plates. **www.agfa.com**

Eltosch Torsten Schmidt GmbH

Eltosch is a world leader in drying systems that guarantee optimal results in the most demanding applications. EItosch pioneered radiation technologies and provides single-source expertise for UV, IR and NIR radiation and hot air drying technologies. Innovative milestones include plug-in technology, Dichroselect-S for cooler UV, Inert UV for sheetfed presses and the new WhiteCure UV module. Constant feedback provides the basis for technical innovation that has been essential to develop the UV/IR/HA dryer system for in-line coating using cross-linking, silicon curing and coating techniques. Founded in 1967, EItosch was acquired by Adphos AG in 2001 and is based in Hamburg; the company provides worldwide sales and service. **www.adphos.de**

MAN Roland Druckmaschinen AG

MAN Roland is the largest supplier of web offset presses and one of the world's leading manufacturers of sheetfed presses. Its major products are web and sheetfed offset presses, digital printing systems, networking and material handling systems that are used by publications, commercial and packaging printers. The company operates out of Augsburg, Offenbach and Plauen in Germany employing about 10 000 staff with an annual turnover of around € 1.5 billion of which 80% come from export. MAN Roland is a subsidiary of MAN Aktiengesellschaft, Munich. The MAN Group is one of Europe's leading industrial corporations with 64 000 employees and annual sales of around €13,5 billion with activities including commercial vehicle manufacturing and engineering. **www.man-roland.com**

Reeves Spa

Reeves is one of the world's largest manufacturers of offset printing blankets with the most comprehensive product line on the market. Vulcan offset printing blankets have been manufactured and distributed all over the world for more than 80 years. Reeves has made major investments in their plants in Italy and USA along with a commitment to research, constant development and product consistency to keep total blanket consumption under control. This technology know-how is a real cost-competitive advantage for end users. Reeves' skilled application specialists and their partnerships with distributors help provide printing quality around the world to ensure immediate assistance to printers whenever and wherever it is required. **www.reeves.it**

Sappi SA

Sappi leads the fast-growing coated fine paper market with a broad range of papers for sheetfed, heatset web offset and digital printing. Sappi's papers are delivered worldwide from state-of-the-art paper mills in Europe, USA and South Africa. It's renowned coated fine papers - HannoArt, Lustro, Magno, McCoy, Opus, Presto, Royal, Somerset and Voltage - are used for annual reports, books, magazines, quality promotional brochures and calendars. Speciality papers include Algro, Leine and Parade for packaging and label applications. The 'Sappi Printer of the Year Awards', 'Ideas that Matter' and the 'Idea Exchange' demonstrate the company's commitment to working closely with the global print community, inspiring customers to be the best they can be. **www.sappi.com**

Sun Chemical Corporation

Sun Chemical, the world's largest producer of printing inks and pigments, is a leading provider of materials to packaging, publication, coatings, plastics, cosmetics, and other industrial markets. With annual sales over $3 billion and 12,500 employees, Sun Chemical supports customers around the world and operates 300 facilities throughout North America, Europe, Latin America and the Caribbean. The Sun Chemical Group of companies includes such well-known names as Coates Lorilleux, Gibbon, Hartmann, Kohl & Madden, Swale, Usher-Walker and US Ink. Additionally, Sun Chemical has many joint ventures, with the largest being its $1.5 billion Kodak Polychrome Graphics joint venture with Eastman Kodak.**www.sunchemical.com**.

UPM-Kymmene Corporation

UPM offers a wide range of paper choices for printed communications. Paper touches the lives of hundreds of millions of people in the form of magazines, newspapers, catalogues, books, envelopes, labels, bags, sacks or office papers. UPM contributes to this with its exceptionally wide range of papers. The company's know-how and use of advanced technology, combined with the desire to find the best solutions for each customer, creates superior products and services. Across continents, UPM sales and distribution companies are working locally with customers to build strong and lasting partnerships. The company is committed to continuous improvement. **www.upm-kymmene.com**

Westland Gummiwerke GmbH & Co KG

Westland Gummiwerke is one of the worldwide leading suppliers of elastomer covered rollers and complete rollers for the graphic industry. Established in 1920, the company's rollers are standard equipment in many new printing presses and its customers include numerous printing companies all over the world. For more than 30 years Westland has developed and manufactured rubber compounds and related technical applications for the printing industry. The basis of Westland's economic success is its coordinated manufacturing processes and intelligent logistics. Westland distributes its products to more than 50 countries through its subsidiary companies, licensees and agencies. **www.westland-worldwide.de**

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