Coates Lorilleux

Technical Information

UV VARNISHING ON DRY CONVENTIONAL INKS

UV curing overprint varnishes provide many advantages when compared to more traditional products such as oxidation drying offset varnishes or evaporation drying varnishes : instant drying, exceptional gloss and superior mechanical resistance. In certain cases UV varnishing can even replace lamination.

Due to these positive benefits UV varnishing over dry conventional inks is a long standing and popular print finishing technique. Nevertheless, even with this long experience, there can still be difficulties. This is due to the wide range of work now being off-line varnished either by printers themselves or by specialist varnishing houses which can involve different substrates, coating systems, drying systems, work practices and in particular the inks and varnishes themselves. The most serious problem is in the apparently unpredictable nature of these difficulties.

Thus, it is not possible to provide guidance which will guarantee a perfect result every time but by being prudent with the choice of materials and following good practices the incidence of failure can be reduced significantly.

Good practices include choosing appropriate inks and coatings, controlling printing and drying conditions, controlling varnishing conditions and above all establishing a management system to be used each and every time printed work is to be subsequently UV varnished.

Successful UV varnishing wet-on-dry over conventional offset inks requires a detailed understanding of potential problems and attention to detail during each step of the process. In effect, conventional offset inks and UV varnishes are formulated from raw materials of a totally different chemical nature which under certain circumstances render the two different product groups incompatible.

Certain precautions can be taken both in formulation and before and during use to avoid incompatibility.

Before being able to establish good practices it is essential to have an understanding of the potential problems which can be encountered and their probable causes.

Common UV varnishing problems

- **Refusal of the varnish** to “wet” the surface of the dry ink and to flow out to give a smooth even film. In extreme cases this can result in one or more of the following adverse effects:
- **Reticulation of the varnish** ; the appearance of “craters” in the varnish film; uneven coverage and widely different gloss levels over printed areas.
- **Poor adhesion of varnish to ink**. This is seen by poor scotch tape resistance. It should be noted that the very best adhesion of UV varnish only occurs when applied over UV curing inks.
- **Flaking, scaling or “candling” of the varnish** evident when the varnish is scratched with a fingernail and the varnish is removed as flakes rather like candle wax. This is caused by poor intercoat adhesion between varnish and ink.
- **Complete removal of ink and varnish together in creases and folds** which is related to the lack of flexibility in the surface coating of the paper or board or caused by the embrittlement of the combined ink and varnish film.

- **Shade changes in the print** particularly when Fanal pigments such as Rhodamine and Purple, or other pigments with poor resistance properties such as Reflex Blue etc. have been used.
- **Sticking or blocking in the delivery pile**, in particular after varnishing both sides of the sheet. This is usually caused by inadequately cured varnish either on the first or second side or both.

Possible causes and prevention

Problems of **refusal** can be detected as soon as the UV varnish is polymerised/cured over the print. **Refusal** is linked to the difference in surface tension of the print and the interfacial tension between ink and varnish. Since **refusal** can be detected immediately after curing a proof print prior to a full print run can confirm the presence or absence of this problem. The use of wetting agents as additives in the UV varnish can sometimes resolve this problem.

Problems of poor adhesion or **flaking, scaling or candling** of the varnish can be detected soon after varnishing or can occur several hours or even days after varnishing. Proof printing will thus not always provide protection from adhesion problems. The problem occurs principally in the printed areas of highest ink coverage or superposition. These problems can be caused by one or more of the following factors :

- Residual petroleum distillate or mineral oils from poorly dried or aired conventional offset inks “sweating” out or exuding from the print. This is a particular risk from the most press stable offset inks and also from metallic offset inks. The risk is highest on printed substrates which have low oil absorbency and with high ink filmweights.
- Using paper or boards which retard ink drying can also lead to these phenomena. This can be caused by excessive acidity in the substrate or retention of excessive fountain solution or both these factors or even other substrate characteristics not well understood.
- If there is poor control of the fount on the press during the print run the ink may suffer over emulsification leading to poor ink drying particularly at the edge of the sheets.
- Using Infra Red drying with an excessively high setting can also cause these problems. When using Infra Red assisted drying on work to be subsequently UV varnished the delivery pile height should be limited and stacks should be well ventilated prior to any print finishing. Ideally the use of Infra Red drying should be avoided if work is to be subsequently UV varnished.
- The presence in the ink of certain waxes or other additives in excessive quantities can cause poor adhesion or adhesion failure can develop on storage due to migration of the wax or other additive to the surface.
- Where there is a long delay between printing and varnishing such that the ink surface is excessively dry and crystalline the surface energy of the ink surface may be too low to correctly accept the varnish leading to poor adhesion.
- For each new work where subsequent UV varnishing is specified it is recommended to advise the ink manufacturer prior to printing the product to be varnished.

The printer should avoid :

- Using too much spray powder has a serious negative effect on adhesion. If absolutely necessary the minimum quantity of an uncoated grade of spray powder should be used.
- Too short a time between printing and varnishing. The minimum delay is 48 hours unless successful UV varnishing with all the same variables has already been completed.
- Too long a delay between printing and varnishing, normally beyond 72 hours, can cause a lack of adhesion due to surface crystallisation and hardening, and a lowering in surface tension.
- Excessive varnish filmweight which can cause insufficient flexibility in the cured UV varnish. There is an optimum filmweight giving maximum gloss and mechanical resistance. Using a level above the optimum, apart from the negative economic factor, will not give an increase in gloss and can cause reduced flexibility and reduced adhesion. If the varnished print is to be folded, as in carton box production, the use of excessive filmweights of UV varnish, even a specially flexible product, must be avoided if good adhesion is to be retained in the folded areas. For these same reasons the risk of flaking, scaling or candling are higher for screen printed UV varnish due to the intrinsically higher filmweight applied.
- Excessive ink filmweights and multicolour builds which can cause excessive accumulation of ink distillates and additives at the ink surface during drying, and reduced surface tension.
- Poor lamp curing efficiency. In particular, in areas printed with strong

dark colours or heavy superposition which strongly absorb UV light a localised curing problem may be evident in the UV varnish resulting in adhesion problems.

- The use of low quality UV varnishes which are very aggressive in contact with print. Those UV varnishes which contain certain volatile amines should also be avoided since unwanted changes in colour or colour bleed may occur (see below). As with the choice of ink and substrate the choice of the correct grade of UV varnish for successful UV varnishing is paramount.

Printing ink resistance properties

Printers must avoid using printing inks which do not have adequate resistance to UV varnish. Serious shade changes can result from the reaction of certain pigments with components of UV varnish. This is particularly evident in pastel and pale shades. Shade changes may not be apparent soon after varnishing and can occur on long storage in the delivery pile or as finished product. These changes are accelerated by heat. Shade changes can also occur by contact of the varnish on the surface side with a tint colour on the reverse side in the stack.

Generally it is recommended to use pigments that are resistant to UV varnish even for colour matchings and especially for pastel colours and tints. Certain UV varnishes are formulated to be less aggressive to sensitive pigments usually by the use of different initiators or synergists.

Double sided varnishing

Perfecting UV varnishing or varnishing with UV varnish on both sides of the paper or card, and in particular with foil blockable or glueable types of UV varnishes, requires great care in avoiding blocking or sticking in the stack. Pile sizes should be seriously limited to avoid heat build up. In any event UV varnishing of the second side should not be attempted until the pile has returned to ambient temperature.

Identification and recovery of substandard print

Before varnishing it is essential to check the surface tension of a print taken from the middle of the stack. There are a number of ways to test for the surface tension, but the most convenient is to use a series of test pens available from various suppliers. Although these are not 100% accurate they give a good indication of the wettability. Surface tension is measured in Dynes/cm and the following figures should be used as a guide :

Below 36	Indication of likely problems
36 to 38	Generally no problems but many borderline cases can occur in this band
Above 38	Problems unlikely

Corona discharge is a technique used by many off-line varnishing trade houses to raise the surface energy of the print but whilst effective in recovering print that has dried too hard, it has less effect if the ink drying has been retarded or if there is fundamental ink / varnish / substrate incompatibility. It cannot be used over metallic inks.

In all cases a prior test of a few sheets should be completed to check for the absence of problems such as candling or reticulation etc. If in doubt, varnishing should be discontinued and the problems investigated.

Choice of inks and varnish

This is the most important element in the pursuit of successful UV varnishing. The manufacturer of printing ink should avoid the excessive use of particular waxes and mineral oils. Certain waxes can have the most serious negative impact on varnishability by causing poor trapping or wetting of the varnish over the ink. Some wax is necessary in the ink formulation to provide adequate rub resistance and surface slip. These characteristics are required to provide the ink surface with sufficient scuff resistance during post print handling which may include cutting, creasing, folding, embossing, stapling, binding or other processes.

When ordering printing ink it is therefore necessary to specify a set of inks that are formulated to allow subsequent UV varnishing. It is accepted that the requirement for one set of inks for both work that is not to be varnished and for work that is to be subsequently varnished will always be a compromise between the requirement for rub resistance and varnishability.

The majority of inks designed for fast work and turn and for rapid post print handling will be varnishable for the majority of work. There can however be exceptions to this and as with all work for subsequent UV varnishing using conventional ink, great care is required. This is especially true when using Infra Red drying. Where possible the use of Infra Red should be avoided if work is to be subsequently UV varnished.

For work known to be difficult for varnishing the best solution is to order a series of inks specially formulated to minimise the risk when UV varnishing. These inks would normally be of greater intensity than standard inks so that the filmweight used

can be kept to a minimum. With all work requiring post print finishing the filmweight should be kept to a minimum. Inks specially formulated for varnishing will be of necessity more expensive than standard inks and are unlikely to have the level of rub resistance normally required for work that is not varnished.

Choice of substrate

Not all printing substrates are suitable for work to be varnished. It has been shown from experience that even using appropriate inks not all substrates provide trouble free varnishing. The key factors are the uniformity of the surface and the absorption characteristics. There is little that can be done if the characteristics of the paper surface are so variable that a uniform impression and a uniform application of the varnish are not possible.

Assuming that the paper is reasonably uniform then the key factor becomes the ability of the paper to absorb the fountain solution on the press, to accept the varnish immediately after varnishing and most important of all, the ability to absorb the components of the ink and to retain them.

Different paper coatings have different absorption characteristics. Paper coatings that are poor with regard to ink absorbency may give rise to varnishing problems soon after printing due to the excessive quantity of printing ink distillate which remains in the ink on the surface thus potentially causing varnish refusal. In addition, some substrates can absorb distillate but not retain them such that ink distillate can « sweat back » to the surface sometime after printing causing latent failure of varnish adhesion.

Tests can be carried out by the ink maker to determine the oil absorption of the surface and therefore predict whether the substrate is liable to give problems or not. There is no substitute for previous experience with regard to being able to predict successful varnishing. Where an unfamiliar substrate is to be used both testing the substrate by the ink maker and a test run by the printer using all the elements which will be used in the run including actual substrate, ink and varnish, is recommended.

Concluding remarks

Although many potential pitfalls have been identified, it must be remembered that the majority of UV varnishing jobs are completed successfully.

Recovering failed work:

With high added value printing where the wrong inks have been used and this is discovered before varnishing, it is sometimes possible to seal the print with an off-line applied nitrocellulose matt varnish or a conventional oil based offset sealer prior to subsequent UV varnishing. If the print run is already UV varnished the only possible route to recovery is to film laminate over the varnished print. This is difficult but can occasionally provide a solution.

To ensure successful UV varnishing wet-on-dry the principal recommendations that should be followed are:

- Never varnish the print unless the printed stack is properly aired and the ink properly dry. There should be a minimum of 48 hours delay after printing with appropriate pile turning.
- If there are any new elements in the “mix” of factors which differ from previously successful practices then a full test should be carried out prior to starting a print run. This test should include the actual inks, substrate, varnish, printing and curing equipment, and as closely as possible the actual conditions that will be experienced in the commercial print run.

Remarks taken from Coates Lorilleux technical information leaflets for conventional ink products (for reference purposes only)

Resistance to alkali (ISO 2838) is used to assess, to a first approximation, the suitability for over varnishing using water based acrylic varnish and some UV varnishes and, in a general way, for resistance to alkaline products. Even if resistance to the standard ISO 2838 conditions is a necessary condition for the expected use of the product in an alkaline environment this result alone may not give sufficient confidence : some additional specific tests may sometimes be necessary (for example, resistance to soap or other cleaning products, resistance to adhesives, etc.)

Resistance to solvents (ISO 2837) is used to assess to a first approximation, the ability of the print to resist solvents and certain print finishing processes (varnishing, lamination, etc.) However, the composition of the materials used can be variable : complementary tests may sometimes be necessary.

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