Hybrid Sheetfed Lithographic Systems—State-of-the-Art

By Anthony Bean

When talking about hybrid systems, most people readily comprehend that a combination of technologies has been used to accomplish an end result. Today, the most common thought that comes to mind is the combination of gas and electric for a more environmentally friendly and better fuel use automobile. In the graphic arts arena, the term hybrid often means a combination of printing equipment (such as a press with both offset lithography and flexographic printing stations to achieve the best that each process has to offer). Burrowing down another layer in the world of UV/EB, a hybrid system could mean a product that utilizes both UV and EB curing systems to achieve a special end product; or it could be a combination-curing mechanism that uses free radical and cationic chemistry or solvent evaporation with UV curing. All of these are viable hybrid technologies with niche applications.

***Photo 1**—Printed brochure showing effect of glossback. This brochure was printed specifically to demonstrate the glossback effect and the quality of the hybrid technology. The cover uses a half page which folds over on itself. The two opposing halves of the image are actually on the same side of the sheet of paper. To print this brochure, an eight-color press was used in which four colors of conventional sheetfed ink and four colors of hybrid ink were printed during the same pass. The entire sheet was flood coated with a UV coating and the entire job was UV cured.*

The hybrid technology this paper will discuss was developed within the sheetfed lithographic market to allow in-line coating of inks that were not traditional UV-curing inks. The hybrid in this situation meant a UV ink with some amount of conventional oil-based materials. For those outside the graphics arts arena, the obvious question would be, "Why not just use UV inks where there is not any problem with in-line coating?" To answer that, a little history is in order.

Not So Brief History

From the very inception of the first run of a UV-cured coating in 1970, a new standard of gloss, chemical resistance and scuff resistance was established—even though some issues of cost, odor and off-taste persisted for many years. The folding carton, publication and commercial markets all wanted the new high-gloss technology to differentiate their products and utilize the technology to grab market share. Brand owners saw opportunities that did not exist just a few years prior. The caveat was that the end result required a dedicated UV press that ran more costly UV ink. The use of UV for everything that a press printed was not always the case in the 70s and 80s. Only in some cases did printers have enough business to dedicate a press to UV technology and run the high-gloss coatings when required.

Over the years, a few printers tried to print both conventional inks and UV inks on the same piece of equipment. Due to the nature of the chemistry available for the press rollers, it was not possible to use UV inks (polar acrylate-based chemistry requiring polar-oxygenated solvent cleanup) with conventional rubber and conventional ink (non-polar oleoresinous-oxidizing alkyds and resins using hydrocarbon solvent cleanup) with UV rubber. Both the inks and especially the roller washes used for one-ink chemistry would destroy the rollers used for the other ink type. To use both types of inks on one press meant that a complete roller changeover was necessary when going from UV to conventional or vice versa. This significantly increased costs due to extra roller inventory and very long make-ready times during the change. It was not practical, but (due to customer demand) some printers struggled through this.

The goal of using the high-gloss UV coatings was always a carrot that printers wanted to offer to their customers. As in any situation in which there is an unmet need, people will try to respond to the opportunity. Solutions were developed for both mechanical and chemical approaches. The “easiest” solution would have been to have the ability to use the UV coating over conventional inks, but when this is done the phenomena known as glossback occurs (Photo 1). Glossback is the decrease of gloss from the original printed result and takes place as the printed sample ages over a typical time frame of 1 to 24 hours. To overcome this, conventional inks with the minimal amount of wax can be printed and then dried. Once the inks are dry, they can typically be UV coated with fairly good success.

However, there are several significant drawbacks to this approach. First, the printer must wait for the inks to dry adequately enough that (when the UV coating is applied) it does not glossback. This timeframe can vary depending on the type of conventional ink, coverage, storage conditions and type of fountain solution used. Secondly, this approach requires a second pass through a coater that incurs more cost. With just-in-time delivery, this also causes delays. Lastly, since this is a conventional ink, it requires spray powder to keep the ink from setting off on the sheet above in the stack during drying and to allow air space to assist with drying. The spray powder on the sheet will detract from the finished UV coated result since the small particles of starch will appear as imperfections in the UV coating. The end result is marginal at best.

Photo 2—*Effect of pigment burnout due to UV coating. The middle carton in the photograph is the correct carton while the carton on either side shows the effect of the pigment burning out due to the effect of the UV coating. Although this situation can be corrected with another coating, the root cause is the improper pigment selection.*

One issue that was not anticipated with UV coating over conventional oil-based inks was that the amine synergists used in many UV coatings can attack certain pigments and cause them to burn out. Photo 2 shows the end result of such an issue when the printer did not consider the possibility. Although the formulators of UV inks are well aware of this issue and avoid these pigments, it is easy for an uninformed printer to accidentally use an improper formulation that is normally acceptable and assume that applying the UV coating will be acceptable.

Due to the issues with direct coating over conventional inks, the use of an in-line, water-based coating was introduced as a solution. The water-based coating was already a standard part of many printing jobs in which it was used to provide consistent coefficient of friction (CoF) across a job, a degree of gloss uniformity (although not as high as UV-coating gloss) and scuff resistance. The coating also eliminated or minimized the need for any spray powder and acts as a primer or tie coat for the UV coating. The negative attribute of water-based coatings is that they must be dried; for this, infrared dryers are used. Drying of the water-based product is impacted by humidity in the pressroom, coating film weight, substrate and press speed. To UV coat the printed water-based primed job, the printer would then have to run the product through his press or coater for a second pass.

This again required more handling, delayed delivery and drove up costs. It did, however, open up the world of UV coating to more printers since they could use UV coating job shops and not have to invest in UV lamps and coating equipment themselves.

Equipment Development

The press manufacturers saw these issues as an opportunity and created double-coater presses. In this scenario, the inks are coated with water-based coating and then coated with a UV product all in line. Figure 1 shows such a piece of equipment. Although this approach works and several such presses are in operation, there are several drawbacks. Certainly, the cost of the equipment increases due to the second coater and the necessary UV curing equipment. Setup of a second coater also requires more make-ready time and requires press know-how, especially as print jobs move to more colors and, therefore, more print units. With two coaters and 7-8 print units, the space required for the press can become an issue. Some of the difficulties of drying a water-based product are more pronounced when the product must be dry enough to accept the UV coating in the short time that is available on a high-speed press.

Slowing down the press is an option, but that decreases productivity.

Both ink and UV coating formulators were working to resolve the glossback issue through chemistry changes. The coating approach never got off the ground because the glossback mechanism was due to the ink chemistry and the coating approach was not able to resolve this. On the ink side, there were two schools of thought—one was to add UV materials to a conventional ink and the other was to add conventional materials to UV inks. The goal at this stage in the development was to come up with an ink that would run on conventional rubber rollers but allow for the printed ink to be in-line UV coated without the problem of glossback.

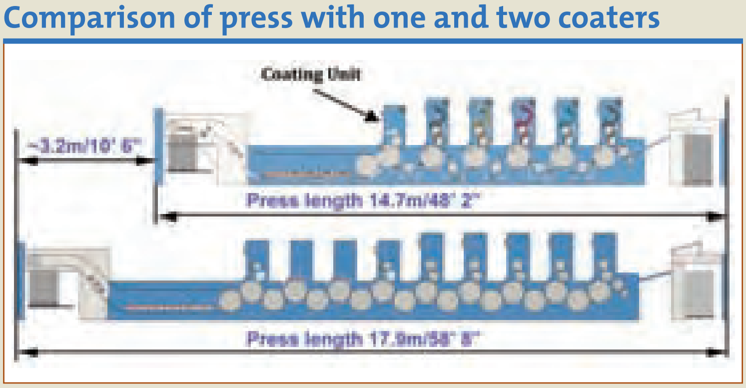
The conventional ink approach achieved a degree of success but glossback issues, although minimized, were still an issue with heavy coverage. This approach was abandoned in favor of a modified UV-curing ink that would cure well enough that glossback was not an issue. The modified UV ink was called a hybrid since it was typically a combination of conventional ink materials and the classic UV materials. For the formulators, this was not an easy task because the solubility parameters and, therefore, compatibility of the two types of materials is significantly different. Since the finished ink would be used on conventional rollers, careful selection of the monomers and photoinitiators was critical relative to the swelling and potential destruction of the rubber, as well as achieving good cure rates.

The cure speed of the inks during the early stages of the development was a problem due to the way that the concept of a hybrid ink was being marketed by some equipment suppliers and unknowing pundits. The initial push was that, with a hybrid ink, a printer would only need to install a UV lamp after the last print unit to set the ink so that the UV coating would not sink into the ink and cause glossback. For any experienced UV formulator, this was an unrealistic, lofty goal. Fully curing straight UV inks would display a small amount of glossback on heavy coverage print layouts when inadequate curing was experienced. Simple logic would dictate that, if the UV technology in hybrid inks was diluted with "conventional" materials, the cure response would not be expected to be enhanced and lead to quicker curing than a full UV ink. Slowly, the correct information was disseminated and printers installed an adequate number of lamps. This did not mean that a press needed to have lamps after every print unit (the ideal situation), but it did mean that enough UV energy was on press and potentially moveable so that (depending on the job layout and the inks with heavy coverage or opaque to UV energy) the print unit could be properly cured to prevent glossback.

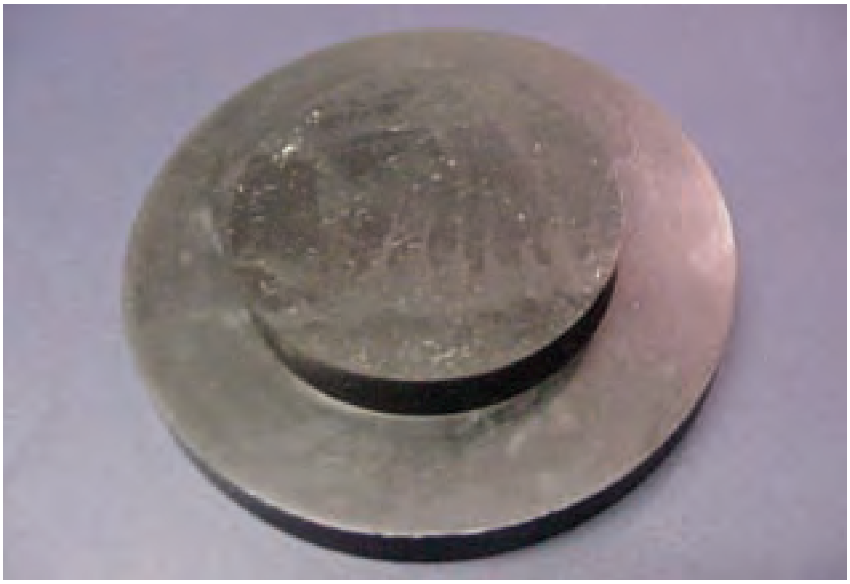
As hybrid inks were introduced, most printers were very worried about the impact of a "UV" ink on the longevity of their press rollers. To try to alleviate printers' fears, many formulators made claims regarding the

FIGURE 1

Comparison of press with one and two coaters



Schematic courtesy of KBA



Photograph courtesy of Bottcher Roller Company.

Photo 3—*Impact of UV ink on a roller sample. The rubber sample was soaked in a UV monomer overnight with the larger outer diameter showing the result of swelling.*

percentage of conventional materials in their inks as a way to claim less impact on the rollers. The reality of the situation was that, regardless of the ink composition percentage, the ink product could not cause roller swell. Photo 3 shows the potential for damage if the ink components attack and swell the rollers.

At the same time ink formulators were discovering how to make inks that would UV cure, run on conventional roller-equipped presses and eliminate the issue of glossback, roller manufacturers saw an opportunity to develop roller compounds that could handle both types of inks. This would give printers the opportunity to use either the conventional ink as a normal product and easily change over to a hybrid ink or even a UV ink when the demand for the properties offered by UV was needed.

Status of Hybrid Inks and Printing

As with any challenge, there are those that will view it as an opportunity and rise to the occasion with products that provide solutions. In the case of glossback and the need to in-line UV coat inks, many solutions were developed and are available today. There are presses equipped with double coaters that can be used to overcome the issue. Although there are several issues with this, there is not any doubt that the use of a water-based primer and a UV topcoat offers advantages relative to surface smoothness and a visual depth that is hard to duplicate.

The roller companies have successfully developed combination rollers (or hybrid rollers) that allow printers to use any combination of conventional, hybrid or UV inks. There are printers who will use this blend not just for a specific job, but will use the combination on some jobs in which they take advantage of specific attributes of each type of ink system. True, these more advanced rollers may cost a little more, but they allow the printer to have much greater flexibility.

Ink formulators have developed hybrid inks that provide a number of improvements. The inks run on conventional presses, eliminate glossback and, generally, have better print performance compared to the conventional UV inks. This last attribute did not go unnoticed and has lead to new UV inks that offer improved lithographic performance.

With the combination of improved “does everything” rollers and improved lithographic UV inks, the question must be asked, “does the market need hybrid inks?” It can also be argued that a hybrid ink is simply a UV ink that does not swell the press rollers. If that definition can be accepted and the press has the newer type of rollers, then UV inks with good lithographic performance may not qualify as hybrid inks but they certainly satisfy the markets needs.

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