Matching solvent-ink parameters to high-speed flexo printing needs

By Jim Felsberg, field marketing manager, Sun Chemical Corp.

Abstract

In today's challenging marketplace, converters are always looking for ways to create production efficiencies or cut operating costs to offset rising expenses for production materials and increasing sustainability compliance. Many converters are improving pressroom efficiency by upgrading presses to increase high-speed capabilities. Flexographic-printing press speeds continue to increase at an unparalleled pace with speeds approaching and even surpassing 2,000 fpm. As press speeds increase, the design parameters for the inks used need to change. These changes ensure the inks dry at the appropriate rate to avoid defects in printed output.

Common defects in high-speed printing

There is a wide range of defects that can occur when inks are used without new design parameters to handle today's high-speed flexographic printing. One example is dirty print, where large clumps of ink build up and transfer to the print web (see Figure 1). This is not traditional dirty print where the dots are bridging, but more of a clump of ink many times larger than the halftone images that transfers to the print web. The defect varies in position from proof to proof.

A second defect – known as feathering – involves ink that spreads out in an irregular fashion on the edge of a solid. This defect is typically seen on the edge of the plate. Instead of a sharp break, the edge of the plate prints in an irregular pattern.

The presence of a faint image on the printing area is a defect known as ghosting. This is typically seen where the anilox roll is plugging and/or the ink does not resolubilize quickly enough for the speed and the doctor-blade opening. Anilox plugging occurs when small amounts of ink dry in the anilox roll, effectively reducing the volume of ink applied.

Another challenge that frequently happens with high-speed presses is misting. This occurs when the ink is transferring from the anilox to the plate and from the plate to the substrate under certain conditions. During the transfer process, a mist of ink will be transferred into the air. The inks will dry into a dust, falling onto press components such as the doctor-blade chambers. Because this dust does not typically transfer to the web, it wastes ink and requires extra cleanup.

Troubleshooting the cause of defects

There are typically three main reasons why the aforementioned defects occur with high-speed printing: 1) The ink drying speed is not correct; 2) The ink resolubility is not good enough; and 3) The ink needs to be stronger in color.

1. Ink drying speed is not correct: One of the most common causes for defects is that the ink drying speed is incorrect. As press speeds increase, the ink drying speed needs to be slower.

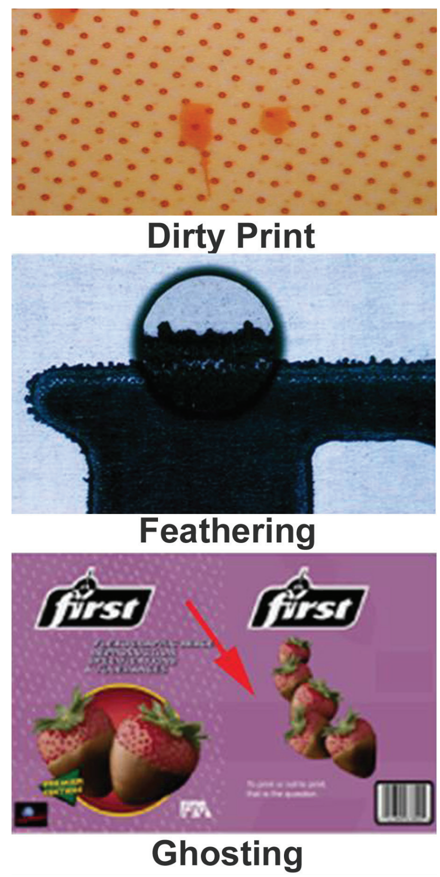

FIGURE 1. *Common high-speed printing defects*

Historically, inks that are based on ethanol tend to dry too fast, so as press speeds increase, a different combination of raw materials should be considered for high-speed presses. For converters that are increasing press speeds only moderately, ethanol may still be used in some cases, but studies show that now more converters are using inks based with normal propanol, which dries slower than ethanol.

Diacetone alcohol and a variety of glycol ethers are solvents that would help slow down the drying of ink on press even further. As more converters have invested in high-speed presses, there has been a significant shift in the solvents used for the flexo-printing process.

According to Figure 2, 85 percent of converters in 2007 used ethanol-based inks for their printing, while only 15 percent used

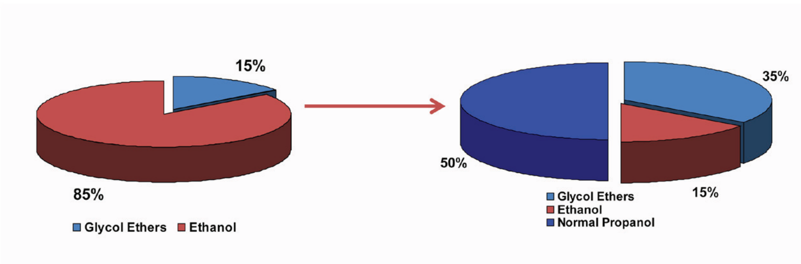

FIGURE 2. *Changes in ink-solvency formulations for high-speed printing from 2007 (left) to 2013 (right)*

glycol ether-based inks. The shift to high-speed printing can be seen in 2013, where 50 percent of converters now use normal propanol for their printing needs and 35 percent use glycol ethers. Only 15 percent of converters today use ethanol-based inks for their printing needs.

The key challenge is to develop an ink-solvent blend that both meets the needs of high-speed presses and maintains stability. Inks are typically not mono-solvent, but contain a mixture of solvents that can include a percentage of alcohol, acetates and glycols.

High-speed presses shear the inks more severely by exacerbating the volatility of the solvents, and it is critical that the ratio of these ink blends stay the same during the press run. If the ink solvency changes over time during the press run, then the inks are not stable and are equally capable of causing defects even with a slower-drying ink blend.

2. Ink resolubility is not good enough: When defects occur as inks dry on plates and aniloxes dry on the high-speed press, it is because the ink resolubility is simply not good enough. Resolubility refers to the balance required between the ink resins and the solvent blend of the ink formulation. If the ink has poor resolubility, the resin cannot re-dissolve the partially dry ink on the anilox roll/plate so that it is transferred cleanly for the next impression. In the microseconds that the ink comes in contact with the anilox in the doctor-blade chamber and the plate comes in contact with the ink in the cells of the anilox, the ink has to resolubilize.

Resins will tend to retain or hold onto the solvents in which they are more soluble. Figure 3 shows a headspace vial with an evaporated solvent blend (Solvent A & B) above a high-speed ink with a general resin chemistry of rosin ester vs. polyamide.

There is a different ratio of solvents – a blend of alcohol and acetate – in the headspace composition above the ink than the solvent ratio in the ink. Polyamide selectively absorbs alcohol and releases more acetate into the headspace and is less tolerant of acetate compared to rosin ester. Polyamide should be more readily resolubilized in a blend containing a higher level of alcohol, while a higher proportion of acetate should favor resolubility of rosin ester.

Solubility Parameter Mapping (see Figure 4) is a way of predicting if one material will dissolve in another and form a solution. The maps are based on the idea that “like dissolves like,” where one molecule is defined as being “like” another if it bonds to itself in a similar way.

This means that re-formulated inks for high-speed printing need to have a wider solubility parameter “window” so that resin solubility is not as sensitive to changes in the solvency and better balance can be achieved inside the solubility parameters. If the resin is more soluble, then slower solvent is needed so that the ink will better resolubilize on the plate and anilox roll.

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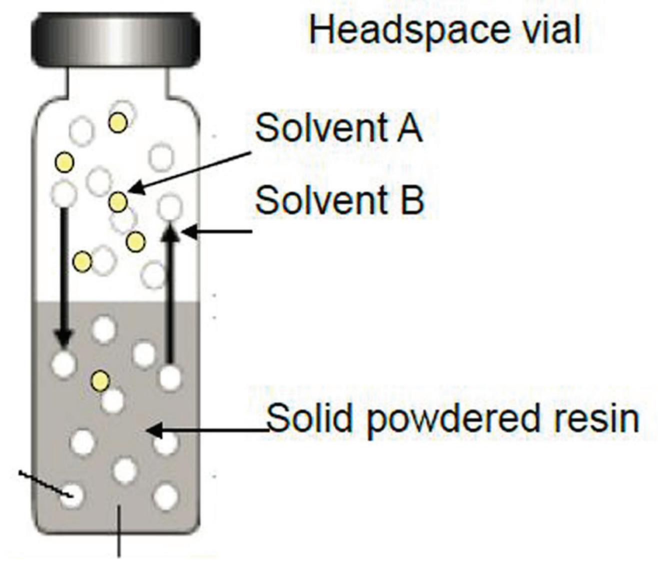

FIGURE 3. *Solvent/resin interactions in a headspace vial*

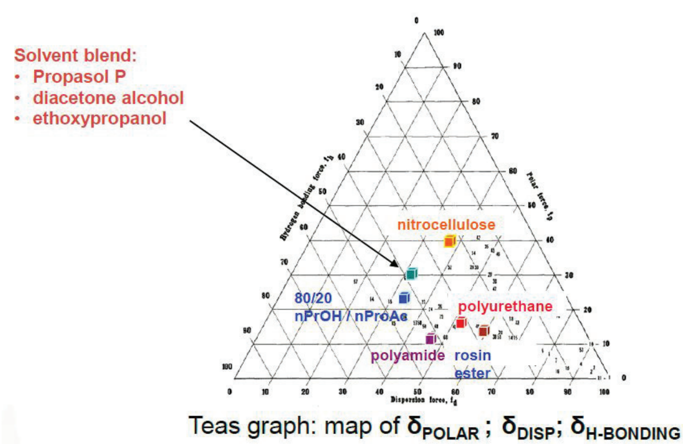

FIGURE 4. *Matching the solubility parameters (δ) of polymer and solvent to improve high-speed flexographic-print quality*

3. Ink needs to be stronger in color: As press speeds increase, typically the anilox volumes must decrease. This is due to the defect of misting. Misting typically occurs when too much ink is applied, yielding a fine ink dust that settles on press equipment.

Misting is seen when the deeper aniloxes are used (above ~6.0-7.0 BCM), so the best solution is to move to shallower aniloxes that minimize the misting defect. However, even with a shallower anilox, the expectation is that the same color strength will need to be delivered. This forces the ink strength to be higher. In summary, using finer aniloxes to get the same color strength requires a stronger ink to be used.

Lamination vs. surface printing

Another consideration for high-speed printing inks is the substrate. Flexible-packaging printers typically need inks designed specifically for surface-poly or lamination substrates.

Inks specifically designed for surface-poly substrates must not only avoid defects such as dirty print and misting, but must provide moderate heat resistance of up to 350 deg F. To maximize optimum printability, it is important that the substrate is properly surface-treated, and the first-down white ink creates a solid and receptive surface to effectively print the next sequence of inks or coatings over the top of the white. Taking these steps will help the inks maintain excellent gloss, printability and adhesion to polyethylene film.

Lamination inks designed specifically for printing on polypropylene and polyethylene substrates using high-speed flexo presses must be formulated to be compatible with a wide range of adhesives. Unlike a surface-ink application, the print sequencing is reversed in the lamination-ink application; now it is the colors that are applied first. They must create a receptive surface for the last-down white and/or adhesive layer to enable excellent printability, adhesion and color traps.

Conclusion

Converters who have invested millions of dollars in high-speed presses to improve efficiencies should always make sure to maximize that investment by using the right ink. By doing so, converters also can reduce costs by avoiding downtime and wasted print.

As ink manufacturers continue to design inks for ever-increasing press speeds, there is a need for resins that are designed to hold onto solvent while printing but release it when subjected to dryers. When inks dry on press, they must have the ability to be instantly re-dissolved on the anilox roll or plate, but not re-dissolve with downstream colors. Inks also need to be designed to adapt to the functionality of the package. ■

Jim Felsberg, field marketing manager at Sun Chemical Corp. (Parsippany, NJ), is responsible for a variety of high-speed flexographic lamination and surface solvent-based ink systems. He can be reached at 704-587-8363, email: Jim.Felsberg@sunchemical.com, www.sunchemical.com