All About Inks

BY DAVID KING

Inks and printers? What to consider when purchasing...

*David King is director of operations for Castle Graphics (**www.castlegraphics.net**), a large format digital printer. He has been in the digital printing industry for more than 20 years and works with a number of major manufacturers to help develop new and better technologies. Catch one of David's seminars at **The Sign Business & Digital Graphics Show** in Charlotte, N.C., September 23-25.*

AFTER WALKING the show floor at recent trade shows and talking with manufacturers' sales people, it has become clear to me that there are many people who don't understand *what* types of inks are best used for *what* applications and *what* machines run *what* inks...

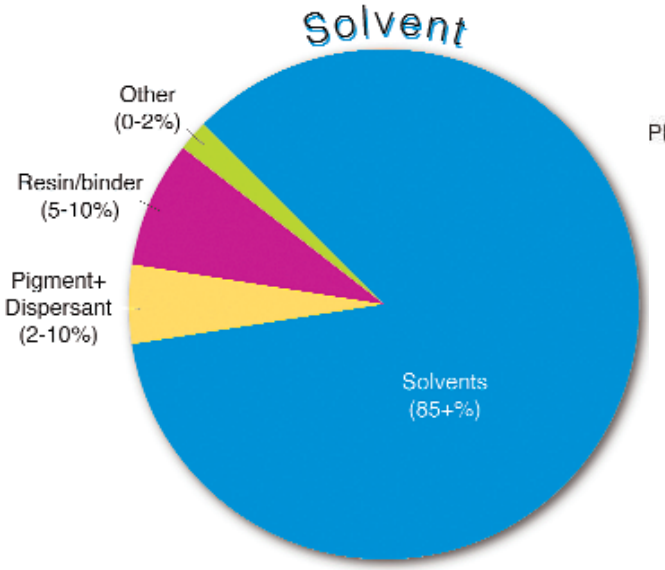
This is a lot of *what*. To help clarify all of this, we should first talk about various types, which kinds of printheads work with these inks, and then look at the applications of the inks.

TYPES OF INK

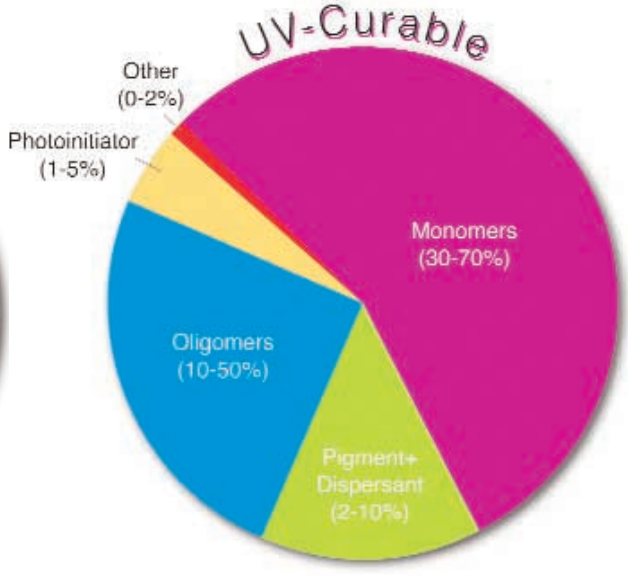
Aqueous-Based Dye Inks — use an aqueous (water) carrier and offer great color vibrancy — some say they have the widest color gamut. Dye-based inks tend to be inexpensive, but will not generally support outdoor or UV-required applications without lamination.

Because these inks use a water-based carrier they tend to run when they come in contact with moisture. As a result, most graphics printed with aqueous inks require laminating.

Aqueous-Based Pigmented Inks — are more expensive than dye-based inks but are better suited for outdoor and archival applications because they offer better UV-resistance. Like dye-based inks, however, aqueous-based pigmented inks are water-sensitive and require lamination for outdoor use. Most of today's aqueous-based pigmented inks offer excellent color gamut.



Although solvents in solvent inks make up the bulk of the formula, they will evaporate as the ink dries.



Charts courtesy 3M Commercial Graphics

UV-curable inks are basically made up of monomers, oligomers, photo initiators and pigments. The photo-initiators act as a catalyst that responds to the UV-lamp, triggering a reaction that causes the liquid monomers to become solid polymers. Oligomers give the ink properties, such as chemical resistance and flexibility.

Aqueous-based inks (both dye and pigmented) are designed to work best with media that has been coated for best ink results. The coatings control ink absorption and provide desirable surface properties.

Acid-Dye Inks — are primarily used for printing onto nylon and silk fabrics. Acid-dye inks are printed directly to the fabric, then the fabric is put into a steam chamber to set the ink. Once steamed, the print is ready to be cut and stitched.

Reactive-Dye Inks — are used the same way as acid-dye inks, but are mainly used for cotton fabrics. Like acid dyes, reactive-dye prints must be steamed to make the image permanent.

Oil-Based Inks — are pigmented inks employing an oil carrier, but they are not very widely used today. They offer excellent stability and low evaporation, but in general, need special media to optimize drying. Xerox and Rastergraphics pioneered these inks, but today only a few printers use oil-based inks (VUTEk's FabriVu fabric printer and Seiko's IP-4500MK-II and 4010Mk-II printers).

Disperse-Dye Inks — are mainly used for dye-sublimation applications (often called dye-sub inks). This ink is very popular for producing images on fabric. For most applications the dye-sub process involves printing a reverse image onto transfer paper which is then run through a heat-press where the image sublimates onto a polyester-based fabric material. The dye actually vaporizes and bonds to the polyester fabric. Newer dye-sub printing systems allow printing directly onto the fabric which is then run through the heat-press. Once the ink has been sublimated to the polyester material (or just about anything that has a polyester coating) the printed piece is finished. In most cases the print does not need a top coat for protection.

CONTINUED

Printing Materials and Printing Results for Various Ink Types

	Bond Paper	Photo-Gloss	Vinyl Banner	Polyester	Cotton	Nylon or Silk	Cast Vinyl	Calendared Vinyl	Boards	Polystyrene	Glass
Acqueous-Based Dye	1	1	3	4	3	4	4	4	5	5	5
Acqueous-Based Pigment	3	2	2	5	5	4	1	1	5	5	5
Acid Dye	5	5	5	5	5	1	5	5	5	5	5
Reactive Dye	5	5	5	5	1	5	5	5	5	5	5
Oil-Based	1	1	2	3	3	3	2	2	4	3	5
Disperse Dye	1	5	5	1	5	5	5	5	5	5	5
Solvent	1	3	1	3	3	3	1	1	2	2	5
Mid-Solvent	1	3	1	3	3	3	1	1	2	2	5
UV Curable	1	2	2	2	2	2	3	2	1	1	3

These results are based on my own experience and on my conversations with other shops.
Key: 1 = ideal, 2 = can print to, 3 = mixed results, 4 = not recommended, 5 = expect failure

Solvent vs. Curable Ink Comparison

	Solvent	UV-Curable
Components	Solvents (85+%) Pigment+dispersant (2 – 10%) Resin/binder (5 – 10%) Other (0 – 2%)	Monomers (30 – 70%) Pigment+dispersant (2 – 10 %) Oligomer(s) (10 – 50%) Photoinitiator (1 – 15%) Other (0 – 2 %)
Image Quality	Substrate dependent Depends on solvent mix Smooth, high gloss images	Generally substrate independent Surface is "textured" – non-glossy
Solidification Mechanism	Ink DRIES by evaporation of the solvent ~10% of original volume is left	Ink CURES by polymerization from exposure to UV light All of original ink volume is left Curing takes place quickly after deposition
Physical Properties	Depend on resin/binder selection Ink layer is thin	Depend on monomer/oligomer selection and curing conditions Ranges from brittle to flexible Ink layer is thick
Substrate Effects	Some solvents penetrate some substrates Can affect physical properties and adhesives	Generally minimal Exposure to high-dose UV light may have a long-term affect on some substrates
Weathering	Largely dependent on selection of resin/binder Improved by stabilizer packages	Largely dependent on selection of monomer and oligomer Improved by stabilizer packages Theoretical advantage due to volume of binder
Equipment	Piezo printheads Heaters/dryers to remove solvent Provisions for keeping nozzles open Generally vented	Piezo printheads UV lamps for curing Less need for spitting, etc. Shielding for UV light Containment for uncured ink, ozone 3M Printer 2500 UV has an oven for use with fabrics

Courtesy 3M Commercial Graphics

Dyes vs. Pigments

Dyes (Primarily for indoor use)

Readily available
Wide range of colors
Stable inks
Prone to fading
Poor waterfastness

Pigments (Useful outdoors)

Good UV stability
Good waterfastness
Fewer color options
Difficult to stabilize
More expensive

Courtesy 3M Commercial Graphics

Solvent-Based Inks — use pigments as colorants, but employ a solvent carrier and are widely used for outdoor applications. Solvent inks dry upon evaporation of the solvent, print directly onto inexpensive uncoated media such as adhesive-backed vinyl, and offer great outdoor durability, often without lamination. Solvent ink is easy to print, has a low cost, and offers good color vibrancy.

In many cases, solvent inks can be used instead of aqueous-based inks. The big drawback is that although the inks dry quickly and have good adhesion, the evaporated solvents emit toxic volatile organic compounds (VOCs), which can cause health and environmental concerns. It is recommended that shops install ventilation systems where solvent-based systems are being used.

Mild-Solvent Inks — were developed by manufacturers in recent years to address health and environmental concerns of true solvent-based inks. Mild-solvent (also called "eco-solvent") ink formulations are much less toxic, require no ventilation, yet still offer the advantage of printing onto uncoated materials for outdoor applications. Printers using mild-solvent inks employ an onboard heater to make the substrate more receptive to the less-aggressive solvents. Initial mild-solvent ink formulations worked best with coated media, however, recent improvements have dramatically broadened the number of uncoated substrates that work well with this type of ink. Roland, Mutoh, Mimaki and Agfa offer printers employing mild-solvent ink systems.

UV-curing inks can print onto just about anything.

UV-Curable Inks — are among the hottest new inks today. Unlike aqueous- or solvent-based inks, the carrier is not evaporated and the ink doesn't dry — it is *cured* using an ultraviolet (UV) light source to change the liquid monomer carrier into a solid polymer. UV-curing inks can print onto just about anything (from foam board to cardboard to glass, vinyl, banner material — you name it). UV-curing inks are widely used in many of today's popular flatbed systems.

Once shot through the printhead, the onboard UV light (attached to the printhead) cures the ink within microseconds. However, in my experience, most of these inks require 24 hours to fully cure and become fully durable. These inks have good color gamut and are great for outdoor applications.

Speaking of applications — check out the chart on page 74 to better understand what materials are best used with different inks.

CONTINUED

Ink Costs For Various Ink Types

	Low Liter Cost	High Liter Cost	Low Cost Per Square Foot	High Cost Per Square Foot
Acqueous-Based Dye	$29	$420	$.04	$.56
Acqueous-Based Pigment	$80	$750	$.11	$1.00
Acid Dye	$200	$600	$.27	$.80
Reactive Dye	$200	$600	$.27	$.80
Oil-Based	$125	$125	$.17	$17.00
Disperse Dye	$40	$650	$.05	$.87
Solvent	$25	$175	$.03	$23.00
Mid-Solvent	$300	$400	$.40	$.53
UV-Curable	$125	$300	$.17	$.40

Low and high costs per-liter based on Online research of suppliers of these types of inks.

ABOUT THE COST...

Now that you understand the different ink types, let's consider the costs involved. With large-format printers, ink costs are all over the board. I wish I could say that there was a simple answer to the ink-cost question, but there is not — so here we go.

If you're going to purchase a large-format printer you should look to see if the printer can be filled by a liter container, or if you must purchase special ink packs or cartridges.

It's fair to assume that all inks will produce about 750 square feet of print coverage per liter of ink, so if your ink pack holds 400 ml of ink and costs $165, then your cost for ink could be figured using this formula:

1000 ÷ 400 x $165 = $412.50 ÷ 750 = $.55 **per square foot**

You will find that some manufactures make claims that your ink will go farther than 750 square feet per liter, but the truth (*Murphy's Law*) is your mileage will vary from job to job, depending on what percentage of ink coverage is required (100 percent black costs much more to produce than, say 20 percent black coverage). The chart below gives you an idea as to the per-liter price ranges and how they translate to cost per square foot.

As you can see by the chart, ink costs are all over the place. The point is, do your homework *before* you purchase a machine!

See you on the show floor... SB

What's up with white ink?

THE LATEST DEVELOPMENT with UV-curing inks is the ability to print using white ink. White has been missing from the inkjet equation since its beginning, mainly because the ground particles for white pigment (titanium dioxide) tend to be too large and heavy for most inkjet nozzles to handle. However, several UV-curable flatbed printer makers including Durst, Mimaki, Azero, NUR and Zünd — offer, or are developing, printers with white ink capabilities.

White ink has a few very interesting applications. You can create a white background on non-white and clear media. You can also overlay with white areas or add spot detail to produce cleaner backgrounds and create more contrast in images.

Right now, however, most screen printers can put down 200 to 800 percent more white than most flatbeds that I have seen. A lot of the white that I have seen from these new flatbed inkjet printers tends to be fairly light and thin. Still, some of these new printers assign two or more printheads to white, and that results in a much more opaque white.

Where white is in great demand is doing 4/4 on clear material (also known as a nine-color job). These are basically window decals that have a four-color image on *both* sides of the decal. To do this you would have to print a four-color image as a mirror print on the clear material, then print white over the top of the image just printed, and then print the four-color image again over the white, but this time not as a mirror print. The image is seen properly from either side. This market has *huge* potential, but so far, I have not seen a digital printer that can do this type of job for large format.

Still, things are changing so fast in the digital world. Soon, manufacturers likely will come out with a very opaque white in order to satisfy the needs of the screen printers' market — and likely at the next show someone will show me a 4/4 graphic printed on a flatbed machine.

But, looking into the future, white ink is a very cool and relatively new development that holds great potential for certain niche printing markets. SB

Real world applications for white inkjet output will become more prevalent as the technology improves and availability of white becomes more commonplace. These images, printed on clear substrates, illustrate white's allure and potential in the backlit POP graphics market. (Images courtesy Durst Image Technology; photos by Jeffrey D.B. Weber)