

# UV-Curable Inks: The Next Step in Wide-Format Inkjet Production Printing

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## Introduction

There's yet another revolution going on in the wide-format inkjet production printing arena. It's more than just the higher speeds, higher resolutions, streamlined workflow and improved productivity we've seen over the past five years. Today the digital printing market is undergoing an ultraviolet (UV) revolution.

The revolution started a few years ago with the advent of flatbed inkjet printers designed primarily as complements or digital alternatives to screen presses. These machines, the majority of which are equipped with UV-curable inks, are becoming increasingly popular in wide-format print production environments of all kinds – not just screen-printing operations – because of the flexibility and productivity they provide. They can print on a wide range of substrates – both rigid and flexible media. The use of UV-curable inks also makes flatbed inkjet printers more environmentally friendly – they do not emit volatile organic compounds (VOCs) thereby reducing the requirement for special ventilation and disposal systems and more easily complying with increasingly onerous environmental regulations in some regions.

The advantages of UV-curable inks have begun to extend beyond the flatbed printing paradigm. UV-curable inkjet printing is now poised to address roll-fed applications – primarily outdoor advertising, superwide (grand format) printing and high-throughput digital printing. Because of their obvious advantages, it is forecast that over the next few years, the wide-format printing industry will witness multiple introductions of new roll-to-roll printers equipped with UV-curable inks. In short, roll-fed printers represent the next step in the UV-curable inks printing revolution.

This paper is an introduction to this latest trend in wide-format inkjet production printing. It covers why UV-curable inks make the difference in both roll-to-roll and flatbed printers – a difference that could result in new business opportunities and increased profits in a wide-format digital printing environment.

In fact, the majority of the wide-format flatbed inkjet printers on the market today already use UV-curable ink technology. The next step is the implementation of this capability in roll-to-roll printers – a trend that will initially be of particular benefit to print service providers interested in, or currently operating, superwide printers capable of output up to 16 feet (5 meters) wide.

As inkjet printing continues to evolve with increased functionality, higher performance, better cost efficiencies, and continuously improving print quality and color rendering, the interest in UV-curable inkjet printing technology is set to explode.

## Definition: Wide-Format Inkjet Production Printing

As wide-format inkjet printing has increased in popularity over the past few years, the breadth of implementations, price points and performance levels has expanded and this sometimes leads to confusion about commonly accepted terminology.

How does NUR Macroprinters define the term “wide-format inkjet production printing”?

Wide-format inkjet production printers and the business opportunity they provide are a breed apart. They can be characterized as follows:

- designed for robust, production environments where fast turnaround time is a requirement and on-demand printing of short runs ranging from several to one hundred copies is fast becoming the norm
- deliver high resolution (up to 720 dpi or better), often employ 8-color printing (CMYK plus light C, M, Y, K inks) for expanded gamut and vibrancy
- operate at speeds up to 1600 square feet per hour (150 square meters per hour) to produce a range of out-of-home advertising materials
- available in roll-to-roll, drum-based or sheet-fed/roll-fed flatbed models in a selection of widths ranging from 5 feet (1.5 meters) to 16 feet (5 meters)
- accommodate a wide variety of printing substrates, from paper to mesh, to vinyl and textiles — both rigid and flexible substrates
- print using solvent-based inks and, increasingly, UV-curable inks for outdoor longevity without further finishing or lamination

Today's range of wide-format inkjet production printers, or grand format printers, as they are sometimes referred to, can open the door to the production of new print applications, new customers, more work from existing customers, higher profit margins – in short, a full suite of profitable new opportunities.

## Why UV-Curable Inks Are the Next Step

Ultraviolet (UV) curable inks are nothing new. They have been used for many years in the cable and wire industry. And they've also been used for a number of years in a variety of graphic arts printing technologies including flexography, lithography and screen-printing.

So what exactly are UV-curable inks and how do they differ from the solvent-based inks we traditionally associate with wide-format inkjet production printing?

UV-curable ink formulations are composed primarily of three components: monomers, oligomers and photo-inhibitors. Monomers are reactive dilutants with a low molecular weight that create a homogeneous solution and impart the surface characteristics of the ink. Monomers are organic solids. They do not release volatile organic compounds into the air as solvents do. Rather they become a part of the polymer matrix of the ink film.

Oligomers form the chemical backbone of UV-curable inks and determine the final properties of the cured ink layer applied to a substrate including the ink layer's flexibility, weather resistance and chemical resistance.

Photo-inhibitors are the third component of a UV-curable ink formulation and they control the start and completion of the ink curing process. They absorb ultraviolet energy from a light source focused at the print surface that causes the photo-inhibitors to fragment into reactive materials. This, in turn, starts a chemical reaction that converts liquid ink into a solid (this process is called polymerization) that adheres to the printing substrate.

The primary factor limiting the use of UV-curable inks in the digital printing market has traditionally been the ink viscosity restrictions of continuous inkjet (CIJ) printheads.<sup>1</sup> However, new printheads have been developed over the past five years that accommodate a dramatically wider range of viscosity.

The latest UV ink formulations offer higher levels of opacity and the ability to cure with a thinner layer of ink. The ever increasing need for speedy turnaround in screen and flatbed printing applications has led to the development of inks with faster cure rates and lower UV exposure requirements. Additional innovations have led to the development of inks with advanced adhesion, elongation, flexibility, and water resistance properties.

All of this has resulted in the development of UV-curable inks that can be successfully used on both rigid and flexible media. And this, in turn, has led to the development of UV-based printing equipment by several manufacturers of wide-format inkjet printers that use UV-curable inks.

## The Advantages of UV-Curable Inks

UV-curable inks demonstrate a number of advantages over traditional solvent-based ink formulations. These advantages include fast curing and drying, few volatile organic compounds for limited impact on the environment, excellent color values and shorter production turnaround times.

## Fast Curing

UV-curable inks change from liquid to solid immediately when exposed to a UV light source. Printed output, therefore, dries instantly and can be handled and stacked or cut without the problems traditionally associated with solvent-based inks – longer drying times, ink offsetting and residual solvent leaking into the room or storage area.

By contrast, solvent-based inks take a longer time to dry, forcing manufacturers of solvent ink-based roll-fed printing systems to build drying systems into their machines (heated platens, rollers or drying units) to accelerate the process. Because the latent heat required to warm thicker substrates like acrylic panels, rigid PVC sheets and display boards is much greater, the drying techniques used in solvent ink-based systems, do not function effectively for some types of media. For this reason, UV-curable inks have become the preferred approach in the latest generation of flatbed inkjet printers that are now becoming increasingly popular.

## Adhesion

UV-curable inks demonstrate superior adhesion to a very wide range of non- absorbent and unprimed printing substrates and good adhesion to absorbent substrates. Untreated media is less expensive than coated substrates, making printing with UV-curable inks potentially more cost-effective. It also means printing systems that are equipped with UV-curable inks are more versatile in so far as the range of substrates on which they can print and in turn, the range of printing applications they can address. UV-curable inks expand the potential number of printing applications that can be produced digitally.

## Fast and Productive

With UV-curable inks there's no worry about ink drying times. This means printing systems equipped with UV-curable inks inherently accommodate fast turnaround times and high levels of productivity.

## Long Print Life

Images printed with UV-curable inks can provide outdoor durability for up to 2 years. In addition, images printed on rigid substrates can be cleaned using strong solvents and cleaners to remove dirt and/or graffiti, giving them a longer useful life. In many cases a lamination requirement can be eliminated, resulting in fewer production steps, increased productivity and lower production costs.

## Environmentally Friendly

As indicated earlier, UV-curable inks contain virtually no volatile organic compounds. They therefore have a minimal impact on the environment and are especially advantageous in areas where regulations to control and reduce solvent ink emissions are becoming increasingly onerous to printing companies.

### **Excellent Color Values**

There is no such thing as an opaque UV ink. Rather, they range in opacity from very transparent to translucent. The high level of transparency produces a very clean color gamut making UV-curable inks an exceptionally good choice for four- or 8-color process graphic printing.<sup>2</sup>

### **Color Consistency**

Because UV-curable inks are heated and jetted at a constant temperature and because a UV light source fixes or “cures” them on to the media, fluctuations in working environment and temperature have a minimal effect.

Lastly, UV-inks also offer several benefits in inkjet printing systems themselves. First, since they cure only in response to UV light, stand times for printheads is practically unlimited. Inks do not dry on the printhead itself. In addition, with no solvent to evaporate, ink composition remains consistent and the inks retain excellent stability in the printhead thereby reducing the need for purging and cleaning cycles. Less maintenance means more time for higher productivity. UV-curable inks also contribute to higher reliability and longer printhead life as well as higher quality, more consistent prints from substrate to substrate.

In short, characteristics like these make UV curable inks an excellent match for wide-format inkjet production printing technology. In addition to their environmental friendliness and instant cure rate, new UV-ink formulations for inkjet printers deliver flexibility and quality while providing excellent durability and high print gloss.

While the advantages of UV-curable ink technology have found initial, widespread acceptance in wide-format flatbed inkjet presses, it is now clear that roll-to-roll printers can benefit equally from this capability. In fact, UV-curable inks are now poised to take roll-fed inkjet printers into a new era of performance and versatility.

### **State of the Market and Where It's Going**

As with many market forecasts and predictions from multiple firms, the numbers don't always match. But the message is the same. The market for wide-format printers that use UV-curable inks is ready to take off. Here are examples from several market research and consulting companies that track the printer industry and forecast trends and growth.

According to the UK-based firm Web Consulting, the sale of digital printing systems that use UV-curable inks will nearly equal that of solvent ink-based printers in 2005. The firm estimates that more than 4,000 ultraviolet wide-format units will be sold during the next four years.

Norwell, Massachusetts-based CAP Ventures agrees with the enormous growth potential for printers equipped with UV-curable inks, forecasting a compound annual growth rate of 56% in the number of units shipped between 2002 and 2007.

I.T. Strategies, based in Hanover, Massachusetts, forecasts the flatbed printer market. It predicts that flatbed inkjet printers, the majority of which use UV-curable inks, will generate hardware, media and ink revenues of

\$614 million by 2008, a CAGR of 23 percent over revenues of \$222 million in 2003.

### **What's Behind These Strong Growth Projections?**

We've already examined some of the advantages that UV-curable inks bring to the world of wide-format inkjet production printing. To reiterate, UV-curable inkjet systems provide all of the expected benefits of traditional digital printing systems and more. They make shorter print runs cost effective and each image can be unique or even customized using variable printing techniques. They deliver a streamlined workflow and lower labor costs – especially compared to non-digital printing techniques like screen-printing, but also compared to traditional printing systems that require printing plates. They also deliver fast turnaround times often enabling print service providers to shorten the time from print order to customer delivery.

Inkjet printing that uses UV-curable inks brings additional advantages compared to other inkjet systems. The most significant is the instant drying, which can occur in 0.2 seconds. Ink curing and drying is independent of the printing speed enabling the development of higher speed printers that can yield faster job turnaround. UV-curable inks are also applicable for more media than water or solvent inks, increasing the range of media – including rigid substrates like glass, acrylics, polycarbonates, paper, box board, textiles, vinyl, polyester, and many more, including less expensive untreated media. The durability of the UV-cured ink can also reduce the need for a lamination step to protect the surface of prints, thereby reducing costs and waste and eliminating a production step that can often be a workflow bottleneck.

In short, the newest generation of inkjet production printers that are equipped with UV-curable inks give print service providers the tools to develop innovative new applications with which to go after a plethora of new business opportunities. This alone makes the future for UV-curable inkjet printers extraordinary – a future in which today's production-oriented wide-format print service providers will surely want to participate.

### **Today's Wide-Format Inkjet Production Printers**

#### **Roll-Fed, High Performance Inkjet Production Printers**

Few will argue that roll-fed, high performance inkjet production printers represent the current state of the market for the production of billboards through point-of-purchase materials and everything in between.

The majority of the roll-fed wide-format, high throughput printers on the market today use solvent-based inks; they have long dominated the market. Solvent inks are relatively inexpensive, deliver wonderful coverage and good outdoor durability without requiring lamination and other treatment. But, they have a strong odor, can create environmental concerns, and they produce a large volume of VOCs.

The primary advantages of these printers are as follows:

- High speed/fast turnaround – high productivity
- High quality, intensely saturated colors
- Outdoor durability
- A range of print resolutions to accommodate both close-up and distance viewing
- Print on-demand, product to order capabilities for fast turnaround
- Cost-effective short runs
- Support for customization & personalization

While they have few disadvantages, their emissions and ensuing ventilation and disposal requirements make them increasingly difficult and/or expensive to operate in some highly regulated urban environments. They are limited to the use of flexible, roll-fed, pretreated substrates that are particularly expensive in superwide widths (16.4 feet/5 meters). And ink drying, product handling constraints can be cumbersome – they require considerable space for these activities beyond the large footprint of the machines themselves.

Despite the few drawbacks, roll-fed inkjet production printers are today the most accepted method of producing outdoor advertising materials (billboards, building wraps, murals, etc.), indoor and outdoor signage, and banners.

This wide acceptance has, however, led to extraordinary levels of competition between print service suppliers, as costs of the machines and consumables continue to drop and demand for wide-format output increases. Superwide printing, in particular, has become a commodity with prices continuously decreasing along with eroding profit margins. Because competition is so intense for lower priced applications, print service providers are looking for new, higher margin applications and for higher productivity levels that will help them reduce their costs. The result is the need for a more cost-effective production method to compete in this price-pressured environment.

This need is particularly significant for print service providers operating grand-format machines capable of output up to 16-feet (5 meters) wide.

There are currently around 1000 such superwide units installed worldwide. Most are four-color machines, a characteristic that limits the variety of applications they can address in today's marketplace where eight-color output is rapidly becoming standard. In addition, about 60% of these machines are over 3 years old (and, therefore, the majority are fully depreciated). They are slow and provide low output resolution making them less competitive for current market requirements in terms of both speed and print quality.

The superwide printers installed today are also solvent-based machines that sometimes means users must install expensive solvent disposal equipment and/or pay penalties for violation of environmental regulations in some areas. New printing technologies that use UV-curable inks can address many of these challenges.

With wide-format and superwide print service providers increasingly looking to differentiate themselves, pursue new customers and develop new and higher mar-

gin specialty applications, many companies have begun looking to new technologies to give them a competitive edge. Enter flatbed inkjet printers.

### **Flatbed Inkjet Production Presses**

Flatbed inkjet production presses, like the NUR Tempo™, were designed primarily to print reliably and productively on rigid and semi-rigid substrates (although some machines, such as NUR Tempo, also have roll-fed mechanisms to accommodate flexible media, making them even more versatile). As such, they were originally aimed at the screen-printing marketplace as more cost-effective companions and supplements to screen presses, most notably for their abilities to economically handle short print runs, which has been a traditional difficulty for screen printers.

The majority of flatbed inkjet presses on the market today use UV-curable inks. In fact, they were the first utilization of UV-curable ink technology in the wide-format inkjet production printing market. It is this capability that gives flatbed inkjet presses their most distinctive characteristics.

Flatbed inkjet printers, with their short media feed paths and fast drying, UV-curable inks are environmentally friendly. They can print on a very wide range of substrates including glass, acrylics, polycarbonates, box board, specialty papers and textiles. This makes them capable of tackling a wide range of applications including outdoor advertising materials/signage, point-of-purchase materials, packaging, textile printing, architectural graphics, wallpaper and home décor and even novel new applications like decoration of home furnishings (window blinds, bath mats, furniture, wall coverings, tabletops, doors, floors, carpets). While many of the media used in these applications are expensive in and of themselves, the cost advantages of printing shorter runs, on demand, directly on them and reducing inventory requirements are perhaps even more persuasive than for more flexible substrates.

For their obvious advantages – media flexibility, environmental friendliness, quality, productivity and streamlined workflow – wide-format flatbed inkjet printers are gaining a major foothold not just in screen-printing environments but in traditional wide-format printing companies as well, companies that want to expand their customer bases, outfox their competition, and offer new and unique services to existing customers.

While not every print service provider needs or wants to print on rigid and semi-rigid materials, the benefits that flatbed inkjet printers derive from their use of UV-curable inks are becoming increasingly attractive.

It seems logical that the next step in the evolution of wide-format printing with UV-curable inks is to bring the benefits they provide to traditional roll-fed high throughput printers. The prospect of fast drying, low VOC inks with high outdoor durability, a high degree of media flexibility combined with the very high throughput, high resolution, fast turnaround, on-demand printing capabilities and cost-effectiveness of a traditional roll-fed inkjet printer have enormous potential.

### **The Next Step: Roll-Fed Inkjet Production Presses Equipped with UV-Curable Inks**

Roll-fed inkjet production printers that use UV-curable inks are the next logical step in the evolution of wide-format production printing. Consider the advantages:

#### **Roll-Fed Printers:**

- Wide and superwide output widths to 16.4 feet (5 meters) to accommodate billboards, building wraps, murals and more
- High speeds to 1600 sq. ft. (150 sq. m) /hour for fast turnaround production of on-demand jobs
- Multi-roll printing across printer width to further improve productivity and better utilize machine capacity
- A range of print resolutions (360 – 720 dpi) to accommodate both close-up and distance viewing
- Cost-effective short runs, support for customization & personalization

#### **UV Curable Inks:**

- Fast drying for ease of material handling, streamlined workflow, high productivity
- Print on cost-effective untreated media for lower costs, higher profit
- Extreme media flexibility to accommodate a wide range of traditional and unique new applications
- Environmentally friendly, low VOCs
- Outdoor durability, long print life
- Excellent color values for high quality color images
- Color consistency

This unique combination of attributes promises to deliver the ultimate in speed, productivity, quality, and versatility – an inkjet production printer that can handle any kind of job with the added benefit of fast turnaround and cost-effective operation. The first of these new generation, high throughput, roll-fed inkjet printers – equipped with UV-curable inks for added flexibility – is now available and print service providers that produce superwide format output will be the first to benefit from them.

These new machines are very fast; their use of UV-curable inks enables fast printing speeds without the need for cumbersome drying ovens. Their speed characteristics alone will contribute to increased productivity and their use of uncoated media will reduce production costs thereby providing better margins and faster ROI, especially in the competitive billboards market. Their ability to print on specialty media such as textiles and other non-PVC substrates will enable the development of new and unique applications and the higher revenues that go with them. Plus lighter media means reduced handling and shipping costs.

The latest generation roll-fed, UV-curable ink inkjet production printers are “green machines” with no VOC emissions. They allow both 4- and 8-color printing (per today’s industry standard) providing the increased versa-

tility to print both far-viewed applications in 4-colors and 8-color, high quality close-viewed jobs.

In summary, the new breed of roll-fed inkjet production printers equipped with UV-curable inks could be just the right platform for print service providers of superwide output. They have the potential to re-invigorate the superwide printing market, reducing operating costs and enabling diversification into new high quality applications and emerging business opportunities.

### **NUR Expedio™ 5000: The First of a New Breed**

In early 2004, NUR Macroprinters began previewing a prototype of a new high-performance superwide and super-fast production printer that is the first machine of its kind to use UV-curable inks. Since then, the machine, now called NUR Expedio™ 5000 has been sparking the imagination of wide-format print service providers worldwide.

#### **What Makes NUR Expedio 5000 so Unique?**

This new superwide printer, capable of output up to 16 feet (5 meters) wide boasts an unprecedented combination of speed, quality, and versatility that position it far ahead of any wide-format or superwide inkjet printer on the market today.

NUR Expedio 5000 can print both 8-color photo-realistic graphics with crisp 10-point type for close-up viewing at up to 720 dpi, as well as 16-foot (5m) superwide prints for billboards at super-fast speeds – 360 dpi at up to 1600 square feet (150 square meters) per hour – making it both productive and exceptionally versatile. The machine can be used to print billboards and other outdoor applications, plus high quality indoor signage and point-of-purchase materials. It’s ability to quickly and easily switch between four- and eight-color printing modes provides maximum flexibility and cost effectiveness. It even provides the ability to print up to three rolls of media simultaneously, further boosting its productivity.

NUR Expedio’s use of UV-curable inks makes it environmentally friendly and eliminates the need for solvent emission equipment or special permits in some regions. UV-curable inks also mean the machine does not require expensive, specially coated substrates for good ink adhesion. The combination of UV-curable inks and a new and unique material handling design that can accommodate inexpensive untreated and specialty media means the machine can print on a wide variety of substrates — from uncoated PVC materials through specialty paper media to textiles – providing low operating costs and higher profit margins. It will also users to explore new printing applications on specialty papers and fabrics, opening the doors to new business opportunities and premium priced applications. We believe that the new NUR Expedio – with its speed, productivity, quality, and media flexibility – has the potential to revolutionize the wide-format and superwide printing market.

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## **Biography**

**Dror Todress** holds the position of marketing product manager within NUR Macroprinters' corporate marketing department. In this role Mr. Todress leads the outbound marketing and business development activities of NUR Macroprinters' UV-based printing equipment. Prior to this position Mr. Todress was a financial analyst within NUR Macroprinters' economics department.

Mr. Todress holds a bachelor degree in economics and Middle Eastern studies and an MBA from Insead, France.