UV-Inkjet Inks: Introduction to the Value Delivery System

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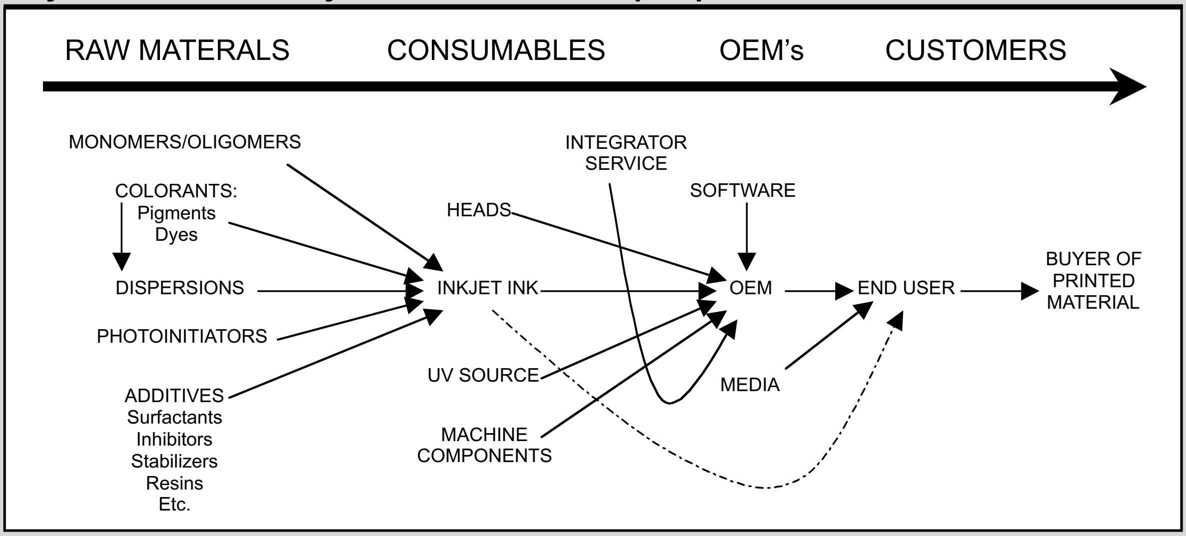
This article is an excerpt from a detailed paper entitled "UV-Inkjet Inks: A Technology Review," which will appear in the September/October 2004, *RadTech Report* on UV Inkjet.

The respective value propositions associated with traditional energy-curable inks/coatings and ink jet technologies are compelling in their own right. It is well known that energy-curable inks and coatings provide valuable emissions control advantages but the real market drivers are improved product performance and increased production efficiency.[1,2] Specifically, traditional energy-curable (e.g. UV&EB) systems provide increased energy savings, faster production rates and floor space savings. Also, low odor/low extractable materials, zero volatile organic content (VOC) and virtually zero hazardous air pollutants are key advantages. On the other hand, industrial inkjet systems may also improve production efficiency. Decreased setup and switch over times as well as decreased consumables waste are enjoyed by inkjet end-users. Further advantages may include lower inventory levels, short run efficiency and shorter lead times. Variable information printing on a wide range of substrates and an overall decreased cost are also among the key market drivers for this type of printing process.[3] Given their respective advantages, it is easy to understand the growing level of marketplace acceptance of both traditional energy-curable materials and industrial inkjet printing.

It stands to reason that a marriage of these two value propositions results in a multitude of commercial advantages for UV-inkjet systems. Recently, Stowe, Caiger and Fuchs described the benefits and key market drivers for UV-inkjet systems in three separate papers.[4,5,6] They suggested that the potential benefits specific to UV inkjet may be zero solvents/VOCs, which facilitates long nozzle open times, hence greater jetting reliability. The life expectancy of the inkjet print head is increased because there is no drying or clogging in nozzles associated with the use of UV-cure inks. Compared to jetting solvent-based formulations, UV inks offer significant head reliability and performance in this area. Instantaneous drying upon exposure to UV radiation as opposed to water or solvent evaporation increases production efficiency. They also suggested that improved opacity and decreased dot gain resulted in improved print quality. At the same time, final prints exhibited increased weatherability, scratch and chemical resistance and decreased odor and taint. It shouldn't be surprising that a growing number of inkjet machine manufacturers and the requisite value/supply chain are starting to adopt UV-inkjet processes.[7] Moreover, a case analysis was recently published by Dave King in which he described how one shop justified the purchase of a UV flatbed inkjet machine.[8] King's bottom line suggested that the increased production efficiency (with similar print quality) using a UV-inkjet machine could result in

FIGURE 1

Inkjet value chain (inkjet ink manufacturer perspective)



significant cost savings that would more than justify the investment. Also, King wisely suggested that one must consider the advantages and disadvantages of all of the components of the value delivery system while pondering the decision to adopt UV inkjet. Each of the major components in the UV-inkjet value chain is described below from the perspective of an inkjet ink manufacturer.

UV Inkjet Ink Value Delivery System

The UV-inkjet ink value chain (Figure 1) from an inkjet ink manufacture's perspective is similar to the traditional/conventional ink value chain with a few subtle but extremely important differences. For instance, new developments along this value chain tend to happen because of strong interactions between the various participants in the value chain. In other words, integrated approaches towards technical challenges have advanced UV-inkjet technology in recent times. Also, unlike traditional printing processes, it is absolutely critical that the major machine components such as the print heads and the UV-source match the inkjet ink and vice versa. Therefore, there are technological constraints, namely materials compatibility, viscosity and surface tension requirements, on the composition and properties of the ink that must be addressed at the time of formulation. Not only does the cured ink have to have good mechanical/physical properties and exhibit good print quality but it also must jet reliably and be compatible with the machine component materials.

Unlike traditional UV-ink and coating formulators, UV-inkjet ink makers require specialized materials given the unique set of technological constraints of the inkjet printing process. Suppliers of monomers and oligomers for traditional inks and coatings recognized the UV-inkjet opportunity. New materials for UV-inkjet formulators are being introduced, which increase the latitude of the molecular weight range and mass fraction. Pigment and pigment dispersion suppliers have also long recognized the need for special inkjet materials.[9] Pigments have been produced for the inkjet market with ultra fine average particle sizes and narrow particles size distributions (D_{avg}<500nm, none above 1000nm) for quite some time. Photoinitiators (PIs) are key components to any UV system including UV-inkjet ink compositions. Given the aforementioned low viscosity constraint for these types of systems, oxygen inhibition becomes an even greater concern with respect to curing efficiency. Activating the PIs and curing the pigmented ink as it jets onto various substrates, at various film thicknesses using various machines is not a trivial matter. The physical properties of the ink film can be greatly affected by the cure. A growing number of choices for UV sources are available allowing OEMs greater flexibility in their machine design including the use of light emitting diodes (LED). Furthermore, more major advancements in the inkjet printing process have been a direct result of advances in the print head technology. Recently, major printhead manufacturers have announced new breakthroughs in precision placements of drops and gray scale printing (variable drop size) thus continuing their technology leadership in the UV-inkjet value delivery system.

UV-inkjet machine manufacturers integrate the components of the UV-inkjet ink value delivery system. There are as many choices as there are applications. A review of the machine offerings available is beyond the scope of this paper and the readers are referred to more comprehensive sources including the article "Large Format Report: Nothing But Net...Profits," which appeared in *Digital Output* magazine in July 2003 as well as "Flat-out Getting to the Profits," which appeared in *Digital Graphics* in October, 2003.[7,8] It is these new machines that are transforming the digital print market.

Summary

The UV-inkjet value delivery system delivers a number of key benefits not the least of which is increased production efficiency with similar print quality. On the other hand, there remains a continuous demand for improving production efficiency, reliability and line speed of UV-inkjet printing processes. Therefore, a tremendous amount of pressure is placed on the developers of UV-inkjet ink technology by the OEMs and end-users in the value chain. The result of this pressure is apparent from the numerous advancements found in the technical literature. OEMs, print head manufacturers and UV-inkjet ink manufacturers continue to develop larger designs, which will offer a wider print area for future commercial graphics, industrial marking and packaging applications. It is these markets that will drive the future success of UV inkjet. Fortunately, a strong integrative approach has been adopted, which will facilitate further refinement and evolution of UV-inkjet ink technology in the future. ◗

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