Digital Labels Printing

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Abstract

The HP Indigo press ws4000 is a high-speed, narrow-web digital press that provides cost-effective short- to medium-run color labels on demand for converters who print labels. With the trend towards fast-turnarounds, higher quality, more colors and shorter runs, label printers, have a real need for the means to improve profitability while meeting these demands. The HP Indigo Press ws4000 offers a complete solution to meet the demands of the Labels printers and the labels users whether it requires special colors, security features, clear or metallic substrates, image changes, numbering, or even personalization. The new HP Indigo Press ws4000 utilizes our Series II engine to deliver up to 105 feet per minute in two colors and 57.5 feet per minute in full color. Unlike conventional printing processes, there are no intermediate pre-press processes between the digital document file and the final print. No film, no image setters, no plates, no platesetters, no photo-chemicals and no waste.

There is also no press make-ready: no plate mounting, no registration adjustments, and no ink keys. HP's process is fully digital from creation to printing. And, since it is fully digital, every image can be a new one, enabling information to be completely varied as required. HP's technology uses offset printing, based on the use of an offset cylinder covered with a renewable rubbery blanket. HP Indigo's ws4000 press employs a 'One-Shot Color' process, as it is not possible to wrap the material around the impression cylinder for multiple passes. In this case, the PIP cylinder rotates several times, transferring a succession of separations and building them up on the blanket, before they are transferred to the substrate all in the same impression pass. Printing with five, six or seven colors, in addition to CMYK, offers major enhancements in color quality, range, fidelity and luminosity. In summary - HP indigo press ws4000 combines digital, offset, and color into a powerful printing process. HP indigo press ws4000 main value propositions for the labels converter are:

- reduce production cost of short- to medium-runs of 35 percent of jobs are under 6500 feet (2000 meters), the ability to run short jobs in a profitable way is essential
- faster turnaround time, on-demand (just-in-time principles)
- with easy setup
- easy and short cleanup
- fast change over
- ability for last minute changes
- no need for films and plates
- added-value printing
- variable information printing
- super print quality
- security features
- high productivity reflect in quick ROI
- end to end solution – printing, finishing and workflow
- industrial production – rigid structure, reliable solution and ease of use
- ElectoInks - 7 colors printing, white color, spot (corporate colors), IndiChrom, IMS, multi layers printing
- substrate flexibility – paper, plastics face stock
- little to no waste – first print is the right one

Introduction

Throughout the 500-year history of printing, the common element in virtually all printing processes has been the use of liquid ink. Liquid ink printed images are of high resolution and brilliant color. HP's unique electronic printing process, called Digital Offset Color, prints directly from electronic data, completely bypassing the need for film and plates. HP's range of printing presses, based on this process, combines high quality imaging, speed, wide color gamut, the ability to print on a wide range of substrates and the option of variations on each printed copy. In this paper we will review the fundamentals of HP's LEP printing process and how it meets the digital label printing market needs.

Digital Offset Color

Digital -

The printed image is created directly from digital data. Unlike conventional printing processes, there are no intermediate pre-press processes between the digital document file and the final print. No film, no image setters, no plates, no plate setters, and no photo-chemicals. There is also no press make-ready: no plate mounting, no registration adjustments, and no ink keys. HP's process is fully digital from creation to print. And since it is fully digital, every image can be varied, enabling each print to be unique.

Offset -

In the printing industry, the term 'offset' is commonly used as a term for the lithographic process. The litho presses use an intermediate cylinder covered with a rubbery blanket that transfers the ink image from its origin on the plate cylinder to the final substrate. HP's technology also uses an offset cylinder and blanket.

There are two main reasons for using an "offset" process. First, it protects the printing plate surface from excessive wear due to substrate friction while printing. Secondly, it compensates for any unevenness of the substrate surface by enabling ink to reach the bottom of any depression. In other words, it acts as a pressure pad, ensuring even pressure distribution, and consequently, even ink transfer from blanket to substrate. Therefore, offset presses can print on a very wide range of substrate surfaces and thicknesses, and in this respect, are superior to non-offset printing. HP's rocess uses offset for the same reasons, thus making it capable of printing on a wide range of substrates. One notable difference between conventional offset and HP's offset printing technology is that HP's ElectroInk transfers completely from the blanket to the substrate without the ink splitting common to all conventional offset printing systems. This means that a new separation, in a different color, can be created for every rotation of the press. We call this 'on-the-fly color switching.'

Color -

HP's technology enables digital printing in full color. Unlike conventional offset litho color presses, which require one complete printing unit per color, our presses print all colors in a single unit.

The Fundamentals of the HP Process

HP's technology is based on ElectroInk – HP's liquid ink. This is a unique tentacular, electrostatically charged pigmented polymer dispersion in an organic dielectric liquid carrier (see fig. 1).

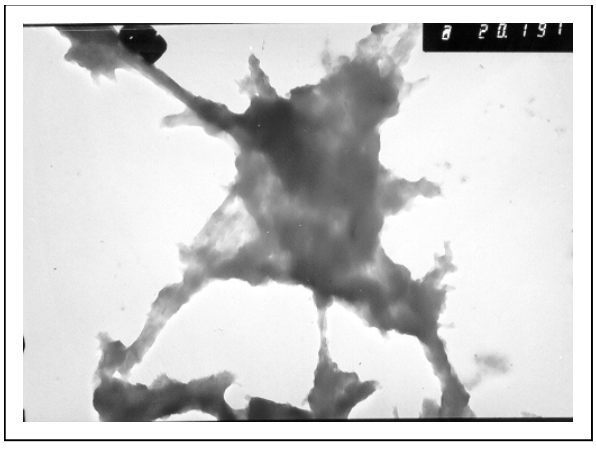

Figure 1. TEM Picture or ElectroInk

As you can see, the particles are not spherical in shape, but rather tentacular, having extended ink tentacles that enable the ink and image to form a mechanical interlock capable of withstanding pressures and facilitating the 100% transfer efficiency of the HP process.

To achieve high color quality in xerography there is a need to reduce the particle size to less than approximately 7 microns . This brings us close to the airborne dust cloud threshold, especially for higher process speeds. Imagine driving on a dry, dusty road behind a truck creating clouds of airborne dust, intensifying as the truck's speed increases. What a dust cloud this will raise. Compare this to driving under the same conditions, but on a gravel road or after a good rainfall – Xerography solves the dust problem the first way, HP the second. It is possible to run at high process speeds using a powder toner, however, the faster the speed the larger the particle size must be to prevent uncontrollable dust. On the other hand, if one wets the particles, even very small ones, with water or oil in HP's case – extremely high speeds are possible, with no dust.

The average mass diameter of a HP's ElectroInk particle is about 1 micron and dispersed in a liquid medium, thus achieving numerous benefits:

- the thin ink layer is similar in nature to high quality offset with no "dust effects"
- the inherent limitation on process speed is eliminated
- the relative particle mass is low (since mass to volume ratio is r^3)
- high resolution
- high uniform gloss
- high color coverage per mass ratio, combined with thin image layers enable fundamental low cost per page.

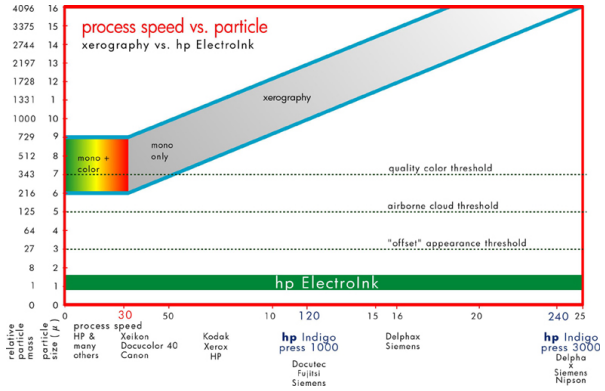

Figure 2. Process Speed Vs. Particle Size

ElectroInk gives a wide color gamut with the basic CMYK. This can be expanded with the Indichrome six color set incorporating Orange and Violet, and extended even further with the Indichrome spot colors mixed from the basic 11 colors. HP's customers can mix their own spot colors on site from a set of basic inks and match most of the Pantone color range. HP also provides white ink for

industrial markets and Fluorescent/UV inks for other specialty uses.

Thermal Offset -

The HP process uses a blanket heated to approximately 100 deg. C. This causes the specially shaped pigmented ElectroInk particles to melt and blend into a smooth polymeric film. When it contacts the cooler substrate, the ElectroInk immediately solidifies, strongly adhering and transferring to the substrate. The print is effectively dry as soon as it leaves the blanket, eliminating any risk of ink 'set-off' marking other copies. This is a major benefit over conventional lithography which requires either assisted drying systems, or a 'natural' drying time of several hours, before any print finishing processes can be applied.

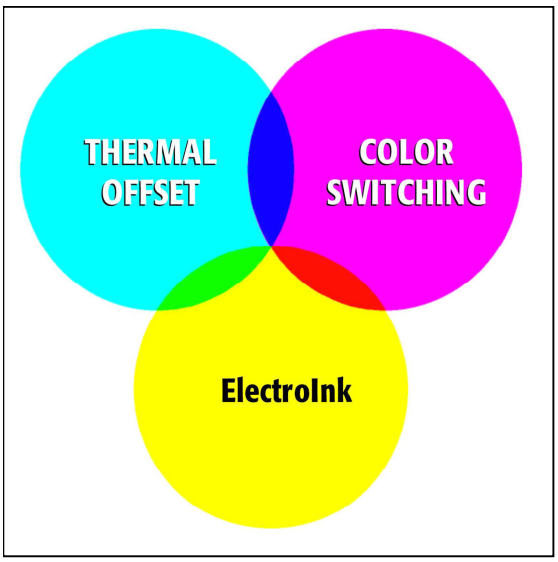

Figure 3. HP Indigo Core Technology

Color Switching -

HP's Digital Offset Color printing technology enables printing all color separations in a single station. After one color separation has been created, the next one, with a different color, is created and printed in the same station.

The HP Indigo Process

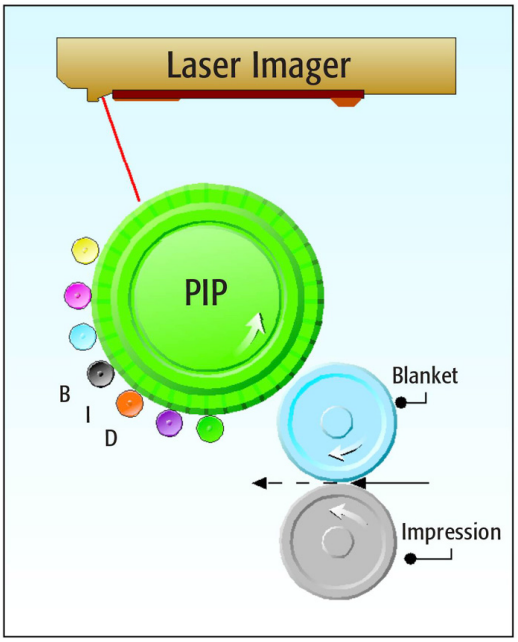

Figure 4. HP Series II Technology

Every HP 3000 engine has a 12 beam laser imaging head delivering 1.6 GB/sec (peak of 2.2 GB/sec) of data to the Photo Imaging Plate (PIP) with an addressability of 3200 x 800 dpi.

One of the predefined 7 colors is then selectively applied to the latent image formed on the PIP.

We call our development process – BID, Binary Ink Development.

Figure 5. BID Schematics

The ElectroInk layer is first created as a uniform film on an elastomeric roller and transferred, image-wise to the imaging plate by electrical forces at the end of the nip. The negatively charged ink layer will transfer to the more positive charged areas on the imaging plate, while the background areas which are more negatively charged will remain clean. This BID process enables very high speed development and is applied in HP's 3000 machine family.

The development or process speed in these machines is 240 ft/min or 73m/min. This high speed development with small particle size is possible only in a process employing liquid ink.

From the Photo Imaging Plate the image is electrostatically transferred to the Imaging Blanket. On this heated blanket, the particles partially melt and blend together until the image becomes cohesive and tacky. You can think of the ink image as a micron-thick hot melt adhesive. The image is then ready to be transferred completely to the paper - without splitting of the ink film. When the ink comes into contact with the substrate, which is significantly below the melting temperature of the ink image, the ink solidifies, sticks to it, and 'peels' off completely from the blanket, ensuring 100% transfer from blanket to substrate. The blanket is therefore clean and ready to accept the next impression as it rotates past the PIP cylinder. The particles, plasticized by the oil have a reduced filming temperature. When the residual oil eventually migrates out of the image, the ink resin returns to its original high melting temperature.

HP has two alternate transfer sequences: the Multi-Shot process and the One-Shot process. In the Multi-Shot process, all color separations are accumulated on the final substrate. The substrate is held on the impression cylinder for several rotations as it receives all separations in sequence. In the One-Shot process, accumulation of the separations occurs on the blanket, and the full color image is transferred in one shot to the substrate.

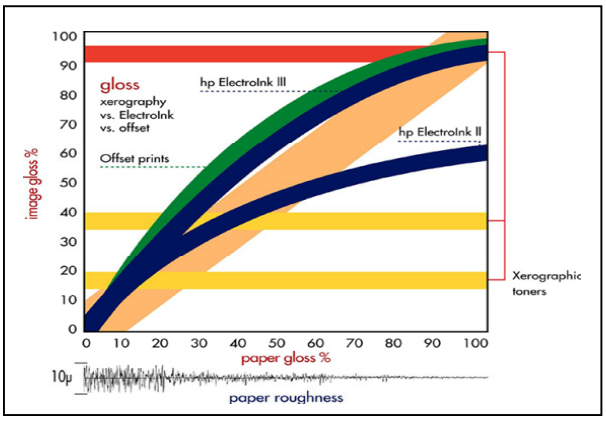

Figure 6. Look And Feel Of Offset

HP Indigo Quality Characteristics

'Look and Feel' of Offset - The ink layer of the HP Indigo print is comparable in thickness to that of offset prints. This gives HP prints the look and feel of offset. A prerequisite for the look and feel of offset is ability of the ink image to replicate the surface gloss of the underlying paper stock. This important quality factor of gloss uniformity, meaning that both shadows and highlights can have a similar gloss, is enabled due to the very thin layer of ElectroInk. This 1 micron ink layer can follow the various paper surfaces, matte, semi-matte or gloss (see fig. 7). It is possible to plot the gloss characteristics of the various digital and lithographic processes on a graph which demonstrates that both ElectroInk and offset printing have almost ideal reflective characteristics, nearly matching the paper gloss for almost the entire range of paper types. Xerographic toners on the other hand, plot as straight horizontal lines on a graph, indicating they have their own gloss regardless of the type of substrate used. This is explained by the large powder toner particles that create thick images which cannot replicate the surface roughness of the paper.

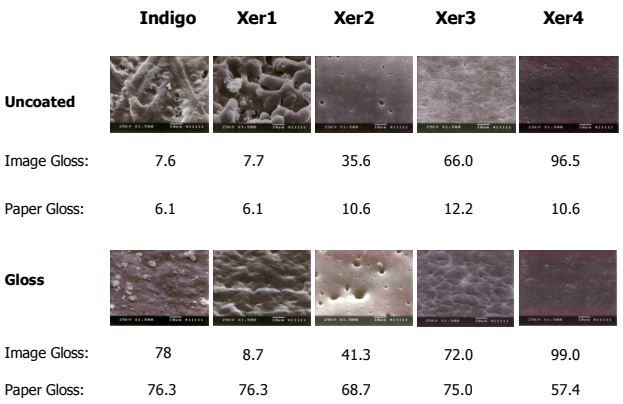

Figure 7. Image Gloss vs. Paper Gloss

Edge Sharpness and Definition

Viewed at high magnification, it is easy to see that the ElectroInk forms much sharper edges than xerographic dry toners, and is even superior in edge sharpness to offset lithography (fig. 8, 9).

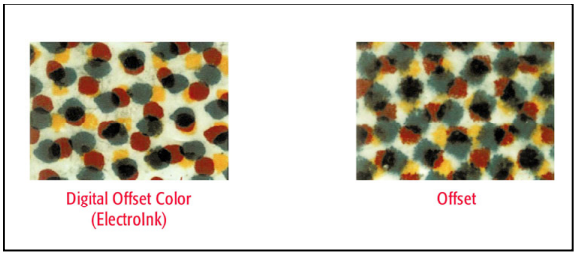

Figure 8.

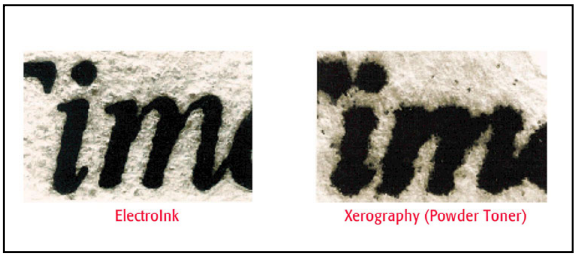

Figure 9.

The sharpness of ElectroInk is particularly visible at the edges of halftone dots, or fine type characters. Also evident is the contamination free background of ElectroInk images. As discussed previously, this is due to the small size of the ink particles, the liquid medium and the manner in which the ink image is transferred as a cohesive film, not as individual particles. When the ink is transferred to the heated blanket and the ink particles melt and blend, the surface tension of the liquid ink facilitates the formation of a sharp, clean edge.

Dot Gain and Color Consistency -

HP/Indigo presses have an automatic closed loop control on both the dot gain and optical density to maintain a consistent dot size and lightness (optical density) for each color. With a conventional offset lithographic press, there are wider fluctuations during a run caused by factors that include: fluctuating ink and water temperature, water/ink balance, plate and blanket wear and atmospheric humidity altering the absorbency of the paper. In adjusting offset presses, a time lag exists between appearance of the problem and the adjustment taking effect, during which many copies are printed. With HP presses there are fewer operating variables and the optical density of the printed image can be electronically set by the operator within a wide operational range. Once set, a proprietary closed loop mechanism, called Color Adjust, monitors and regulates the print density and the dot size throughout the job run. The machine will also save the specific job settings for repeat runs in the future, meaning that a repeat job will be identical to the original. This is difficult to achieve with lithography which depends to a great extent on operator skill.

HP-Indigo ws4000 Digital Press for the Label Market

HP's commercial and industrial printing product lines enable customers to choose the product best suited for their unique needs and applications, print volume and budget requirements.

In September 2002, HP-indigo introduced the new Digital Web Fed press for the label market – the HP-indigo ws4000 (*fig. 10*). This unique press can run up to 32 meters per minute (2 colors or 16 meters for 4 colors) and can print up to 7 colors including CMYK, white and a wide variety of spot colors. The press has the capability to print on a wide range of substrates and label types; from paper face stock, synthetics and plastics to metalized face stock – all with outstanding image quality.

The HP- indigo "One-Shot" process is being used in the ws4000 press. This unique process enables to print on web media by accumulating all the image separations on the Blanket and then transferring the full registered image in "One-Shot" to the web material. With this process, the image is transferred all in once, enabling to print also on both thick and non flexible media (cartoons) and thin, temperature sensitive materials. The flexibility of this process gives way to print images up to 16 layers (from the same engine), thus for example you can build a duplex image printed on a transparent plastic substrate with up to 7 colors on each image and a white ink layer in-between.

The label market requires a wide range of media types and weights. The Hp-indigo technology based on the thermal transfer process as explained above, enables transfer to almost any substrate where linear contact with the Blanket is achieved. Today a wide range of label substrates can be found which are optimized for the HP-indigo process and our customer's need.

It is widely known that good looking labels can improve the selling of many products (did you ask yourself

how you really choose a bottle of wine in the local supermarket?) - therefore brand owners are demanding high quality and precise color matching for their branded jobs. HP - Indigo is offering a solution for the high quality label printers through the form of the Hp-indigo Ink Mixing System called the IndiChrome off-press system. With the HP IndiChrome off-press you can specify and pre-mix PANTONE colors and special spot colors where screened tints are not acceptable, or where regular or large volume use makes it cost-effective to mix special ink batches. You then load them onto the press into the 5th, 6th or 7th ink tanks, on a per-job basis.

Spot colors are manufactured and supplied by HP and by certified 3rd parties, or you may prepare them onsite with your HP IndiChrome Ink Mixing System. What's more, these special colors can be mixed to match either gloss-or matte-coated substrates.

Figure 10.

Biography

Udi Chatow received his B.Sc. and M.Sc. degree in Physics from Tel Aviv University. Since 1988 he has worked at HP, Israel in several R&D positions among them Project Manager, Ink Department Manager and since 2002 as R&D Director managing the Materials R&D.