Product Technology of Eco-Solvent Inkjet Printer M-64s

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In the earlier days (before the year 2000), the sign & graphics industry employed wide format inkjet printers that used water-based pigment (hereinafter, referred to as aqueous) ink. Aqueous ink requires inkjet media with ink-receiving layer, and it cannot be used to print on PVC-based media, which do not have a receiving layer. Then in the 2000s, wide format inkjet printers using solvent-based (hereinafter referred to as a solvent) ink began to appear. These printers are capable of directly printing on media that do not have a receiving layer. This revolutionized the digitization of the sign & graphics industry and dramatically improved productivity of printed products for outdoor use. In such a market environment, OKI placed emphasis on balancing high-speed printing with high image quality to develop the solvent wide format inkjet printer, the M-64s. This article introduces the product technology employed in the M-64s.

Difference between Aqueous and Solvent

Figure 1 shows the media fixing process of aqueous and solvent ink. Even without the receiving layer required for aqueous ink, the solvent ink itself erodes and penetrates the media surface to fix the color material (colorant) thus forming an image. Although a heat source is necessary to evaporate the excess solvent component, the colorant is fixed strongly and has excellent weather resistance making it suitable for printing outdoor signage.

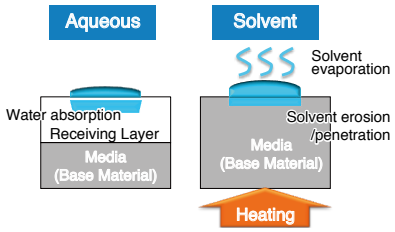
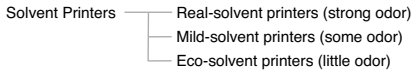


Figure 1. Difference between Water Pigment and Solvent Fixing

OKI Data Infotech's Solvent Printer

After launching the first generation solvent printer in 2002, OKI announced in 2003 a series of solvent printers (Color Painter series) that surpassed print speeds of competitors and made a full-fledged entry into the sign & graphics market. Since then, remarkable technical advancements have led to the handling of a wide range of printing applications. With respect to solvent printers, transition was made from strong odorous ink (real-solvent, mild-solvent) to an ink that was less odorous (eco-solvent), which is now mainstream in wide format inkjet printers for sign & graphics use. OKI began production of eco-solvent printers in 2011 and the M-64s is the latest model.



(Note) Solvent printers fall into one of three classes depending on the solvent type.

Figure 2. Classification of Solvent Printers

Market Trend and Size

The largest worldwide shipment of wide format inkjet printers (24 inch or wider) belongs to the aqueous printers followed by eco-solvent printers. However, aqueous printer shipment is gradually decreasing as opposed to eco-solvent printer shipment, which is showing a slight upward swing. This trend is expected to continue a while longer.

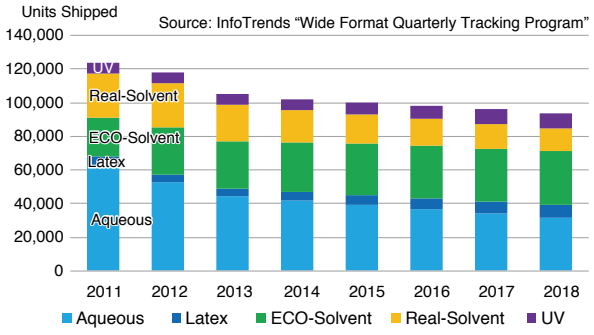


Figure 3. Worldwide Shipments of Wide Format Inkjet Printers

On another front, UV and latex printers are gaining significant traction although their shipments do not match the levels shown by the above printers. The rising popularities can be attributed to the fact that

they are new technical alternatives to solvent printers. Additionally, there are growing interests in VOC (Volatile Organic Compound) regulations and environmental considerations. OKI is responding to environmental concerns with its low-odor eco-solvent printer and is now working on the development of high-speed printing and high-quality imaging specialized for signage applications.

M-64s Product Concept and Target Applications

Using eco-solvent to achieve high-speed printing and high image quality, M-64s was developed for improving both productivity and operational environment (output environment/ease of use) sought by the customer. In particular, high density printing at high-speed, which could not be achieved with conventional eco-solvent printers, and weathering performance important for outdoor printing were realized with newly developed low-odor eco-solvent ink and proprietary printing system. Developed under this product concept, the M-64s can be used in a wide range of printing applications as shown in **Figure 4**. Print control technology to print high color, high weather resistant vehicle wraps or rich, wide color gamut on illumination film-based media among others without drop in print speed is OKI's specialty and has become the product appeal of OKI's solvent inkjet printers including the M-64s.

Figure 4. Target Applications

System Technology Employed in the M-64s

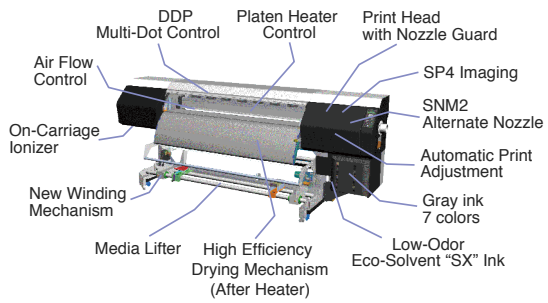


Figure 5. M-64s Technical Features

This section describes some of the technologies behind the M-64s' high performance. Actual development addressed over 100 topics that included solutions to issues with previous printers and new ideas derived to meet customer needs. The effort dramatically improved the overall performance of the M-64s. **Table 1** is some examples of the technologies incorporated into the M-64s and each will be described in order.

Table 1. Some Examples of M-64s Technologies

	Topics	Purpose/Benefits
1	High-speed, high-quality printing mechanism	High productivity and image quality
2	Low-odor eco-solvent ink	Improve output environment
3	Airflow system	Improve printing stability and drying
4	Automatic print adjustment (feed/reciprocal adjustment)	Simplify print adjustment
5	New winding mechanism	Reliable winding
6	On-carriage ionizer	Measure against electro-static media
7	Smart Pass Technology (SP4)	Eliminate banding and improve image quality

1) High-Speed, High-Quality Printing Mechanism

In order to increase efficiency of high color, high density imaging demanded in the sign & graphics industry, the M-64s prints switching dynamically between three different drop sizes. The Small Drop Size shown in **Figure 6** is the smallest drop (about 12pl) while the Medium Drop Size and Large Drop Size are about double and triple in size of the small drop, respectively. Print control is achieved using a print head capable of emitting highly dense ink and OKI's proprietary imaging algorithm, which are basic technologies in OKI's printer systems. The result is a rich, sharp image using small amount of ink and without a slowdown in print speed.

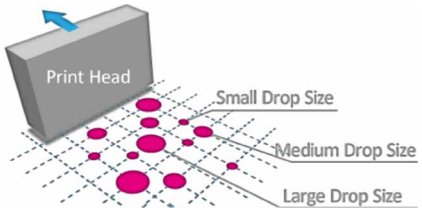


Figure 6. Imaging using Three Ink Drops

2) Low-Odor Eco-Solvent Ink

Prior to the development of the M-64s, high density low-odor ink with excellent drying property was developed. In addition to the process inks (C, M, Y, K), the M-64s includes light inks (Lm, Lc, Gy) enabling high quality image presentation even in halftones. The 1.5L ink cartridge is three times the capacity of entry-level printers.

Furthermore, the M-64s has built-in sub tanks that allow ink cartridges to be replaced without interruption in printing, thus easing the mind of even high volume users.

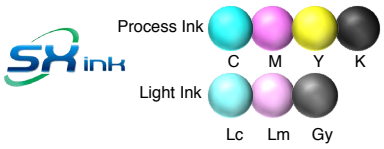


Figure 7. Eco-Solvent Ink for M-64s

3) Airflow System

To a high-speed solvent inkjet printer that handles long prints, internal temperature monitoring and airflow design become extremely important. The internal heater and airflow of the M-64s have been optimized for reliably drying media in standard print mode.

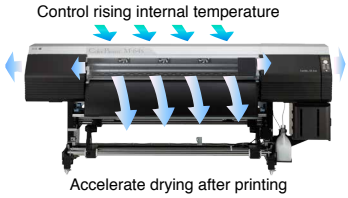


Figure 8. Airflow System

4) Automatic Print Adjustment (Feed Adjustment/ Reciprocal Adjustment)

Automatic print adjustment is the same function as in consumer inkjet printers, but its use in wide format printers is rare. Normally, in wide format printers, it is necessary for the customer (operator) to make print adjustments for each media used to obtain high quality. However, adjustments are felt bothersome and sometimes bypassed or the level of adjustment varied since it is operator dependent. As a result, printers were unable to exhibit their true printing performance (quality) and lead to quality claims from customers. In order to resolve this issue, the M-64s is equipped with a function to automatically detect and register the optimal print adjustment value (feed adjustment value in the media transport direction and reciprocal adjustment value in the head scan direction) for each media. This function allows anyone to easily make print adjustments and obtain reliable print quality without relying on operator experience or expertise.

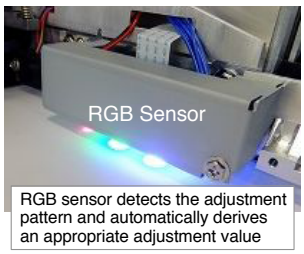


Figure 9. Automatic Print Adjustment Mechanism

Through numerous evaluations over an extensive period, OKI was successful in developing an adjustment pattern and detection algorithm to derive accurately, in a limited time, the optimum correction values for a wide variety of media and multiple print modes retained in the printer. The automatic print adjustment specification for the M-64s is an adjustment resolution of about 0.1% in the feed adjustment and less than one pixel in the reciprocal adjustment. The level of adjustment achievable with the automatic adjustment function should pose no problem in practical use.

5) New Winding Mechanism

With previous printers, when winding the media after printing, the orientation of the media sometimes caused media jams to occur. As shown in **Figure 10,** in the new winding mechanism, the media detection method and detection sensor (light emitter/light receiver) placement have been changed to control the amount of media slack to fall within a proper range during winding. This stabilizes the media's orientation and the media can be wound cleanly. For high productivity printers, reliability of long printing and winding is very important, and with the change in sensor mechanism, unattended operation is possible.

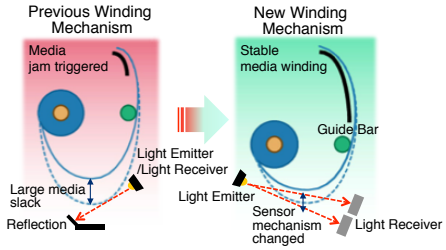


Figure 10. New Winding Mechanism

6) On-Carriage Ionizer

In the sign & graphics market, a variety of media is being used all over the world. Among them are media that are electrostatically charged (or the charge has not been neutralized) causing ink mist to be electrically absorbed into the media and degrading print quality. Moreover, this phenomenon does not always occur, but it is known to depend on media type, the charge status of the media surface or seasonal factors (in particular low-humidity environment). As a measure against such unstable events, the M-64s electrically neutralizes the media surface during printing with an on-carriage ionizer

(small ionizer placed on top of the carriage) to prevent ink mist from adhering to the media. This function is effective on media such as synthetic paper, which is prone to electrostatic charges, and expands the media support of the M-64s.

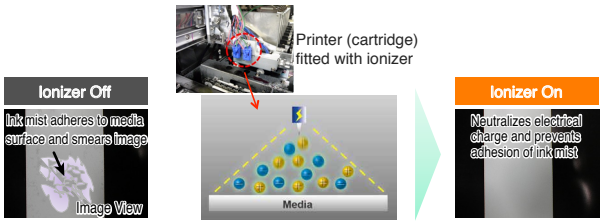


Figure 11. On-Carriage Ionizer

7) Smart Pass Technology (SP4)

OKI calls the algorithm to alleviate print banding, which is specific to inkjet printers, Smart Pass Technology. This is OKI's proprietary imaging technology, and the fourth version of the algorithm (hereinafter, referred to as SP4) was developed during the M-64s development. In forming the image, SP4 optimizes the inks' drop sizes and the order in which they impact the media according to the characteristics of the inks and media. **Figure 12** is a conceptual diagram depicting the difference between version 3 of imaging algorithm (hereinafter, referred to as SP3) and SP4. When printing three different pixels with SP3, the same large sized ink drops are separately emitted by each scan to form the pixels. In high-speed print mode, this method caused mottling (spotty print image), which is a phenomenon specific to inkjet printers using solvent ink, to occur resulting in a deteriorated image quality. On the other hand, SP4 splits a pixel comparable to a large sized ink drop into two smaller drops and forms a single pixel using several scans. This way, even printing at high-speed and low resolution, solid fill (uniform with no white spots) is good, mottling is prevented, and graininess of the formed image is fair. That is, the feature of this technology is the optimization of resolution and ink amount (= ink drop size) according to the behavior (mottling characteristic) of the ink just after it impacts the media during high-speed printing. This idea stemmed from the control technology that takes full advantage of the print head capable of multi-ejecting the approximately 12pl ink drops, and it differs from the print control of inkjet printers that utilize fine pitch print heads. The technology is OKI's proprietary imaging technique and differentiates OKI from the competition.

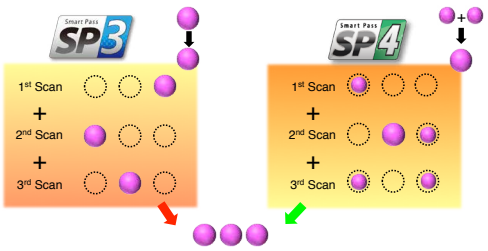


Figure 12. SP4 Conceptual Diagram (Multi-dot Imaging)

Patent Applications for Inkjet Printing Systems

OKI is also focusing effort on patenting its proprietary technologies related to inkjet systems. This final section presents an overview of OKI's inkjet technology patents.

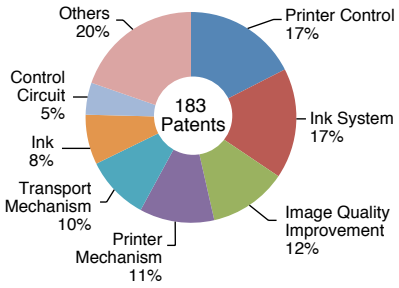


Figure 13. OKI's Published Wide Format Inkjet Patent Categories

Figure 13 is the ratio of OKI's patents by category published from 2010 to 2015. Patents related to printer control, ink system, image quality improvement and transport mechanism account for about 60% of the total. Print head and ink, which are key elements of an inkjet printer, utilize OKI's technologies described earlier and their implementation in the product helps balance high-speed printing with image quality. The technology developments are directly linked with the provision of value to customers and are believed to be the differentiating technologies. OKI will continue with the technical development of products that fully utilize the latest print heads and high performance inks developed to meet market needs.

Conclusion

Thus far, OKI has been focusing on the development of printing systems for inkjet printers that enable high-speed and high-quality printing. It has been proceeding with commercialization of wide format solvent inkjet printers for the sign & graphics industry and in particular targeting outdoor commercial printing. However, in the

sign & graphics industry, application field is widening (broadening base of digital commercial printing) due to the printing adaptability to wider variety of media, and there is growing interest in eco-friendly printers. In light of this market trend and direction of technical development, OKI plans to proceed with the development of printer platforms for indoor/outdoor commercial printing applications and the application of next generation component technologies (print head/ink). OKI also intends to meet the sign & graphic market needs worldwide and continue to transform the industry.

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TIPS【Glossary】

Sign & graphics
General term referring to indoor/outdoor posters, ads, billboards, banners, vehicle wraps, illumination displays, etc.

Process ink
Refers to the 4-color ink that includes Y (yellow), M (magenta), C (cyan) and K (black).

Light ink
Refers to highlight inks with lower pigment density. Examples include Lm (light magenta) and Lc (light cyan).

Print banding
Refers to the regularly occurring horizontal stripes in a printed image. Mainly occurs in shuttle-type inkjet printers, thus banding removal technology has been developed.