Inkjet Printing System for High Print Quality on Offset coated Paper

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Abstract

Recently, inkjet printing has been gradually replacing some of the offset pressing printing applications since it can easily handle small quantity and large variety printing production. We are offering RICOH Pro VC60000 to cover this customers' requirements on not only plain paper but also offset coated paper. To achieve high print quality especially on offset coated paper, we introduce the key technologies on this system such as SUS based 2-inch wide print head, Pigment based Quick-Drying Ink (QDI), Under Coat Liquid (UCL), Protector Coat Liquid (PCL), and Strong Dryer Unit.

Introduction

Print volume for the field of the commercial printing is approximately 34,000 billion pages a year worldwide now and mainly offset pressing has dominated this market for many years. Some applications, however, in the market can be replaced with the digital printing recently and products that are based on electro photography or inkjet have been gradually increasing in this market. Although digital printing is not suitable for mass printing at high speed, it takes advantage of its possibility of variable data printing and can easily handle small quantity and large variety printing production, which the print volume would be expected to grow from approximately 20 billion pages to 70 billion pages a year worldwide in four years.

We, Ricoh Company Ltd., unveiled RICOH Pro VC60000 in September 2014. It is a new product addition to RICOH InfoPrint 5000 series that has been sold since 2007. RICOH Pro VC60000 is an inkjet technology based printer and is able to achieve not only high print quality up to 1200x1200 dpi but also fast printing up to 120mpm at 600x600 dpi, handling up to 20.5 inches wide paper.

RICOH InfoPrint 5000 line was primarily focusing on the transaction applications however the marketplace for this kind of printer has been shifting to short run publishing on many types of paper, therefore this customers' requirements should be considered.

To meet this customers' demand, the distinct feature for RICOH Pro VC60000 is the capability of printing on many types of paper such as offset coated paper, inkjet coated paper and plain paper so that customers can cover from Transaction printing applications to Print on Demand (POD) applications only on just one system.

However, high speed and high image quality printing on offset coated paper by aqueous ink jet technology will pose a challenge because ink is harder to penetrate into this kind of paper and it is more difficult to fix it firmly on the surface on the paper due to its surface treatment. This physical properties of this type of paper will also impact dryness of the ink on the substrate.

The Whole system of VC60000

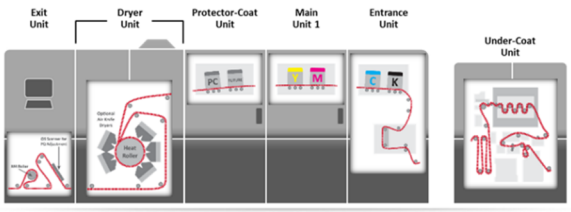

Fig.1 Whole RICOH Pro VC60000 system

Fig. 1 shows the whole system of RICOH Pro VC60000. Basically, when printing on offset coated paper, the paper is pre-coated by Under-Coat Unit first, then, fed into main printer, which contains printing unit for four colors and Protector Coat and Dryer Unit. Also, CIS scanner is implemented in the Exit Unit to calibrate image quality.

The configuration can be customized depending on the customers' applications, for instance, Under-Coat Unit and Protector-Coat Unit can be removed from the system when printing only on plain and ink jet coated paper, Air knives can also be removed depending on customers' requirement. Customers are able to configure the system freely whatever they need.

SUS based 2-inch wide print head

To create high quality image at fast print speed, we introduced SUS based 2-inch wide print head to the system.

SUS based print head, which we originally developed with our own technology [1], [2] is 2-inch wide and its resolution is 600 dpi. Fig.2 shows two print heads are put together on one housing, as a print head module, with shifting by a half pitch to achieve 1200 dpi.

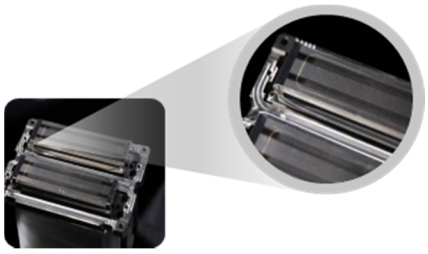

Fig.2 Dual print head module

This print head has high rigid piezoelectric actuators and is capable of dealing with wide range of viscosity liquid [3], [4]. Fig. 3 describes bi-pitch structure of piezoelectric chambers in the print heads.

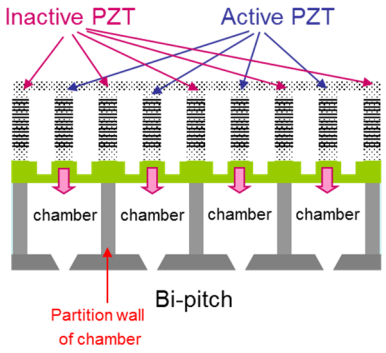

Fig.3 Bi-pitch actuators

Inactive and active PZT actuator is placed alternately so that partitions of chamber can be hold tightly and the print head can deal with wide range of viscous liquid.

Additionally, Modulated Dot (M-dot) technology is introduced in order to create wide variety of ink droplet volumes, covering from high speed printing to high quality printing (Fig. 4).

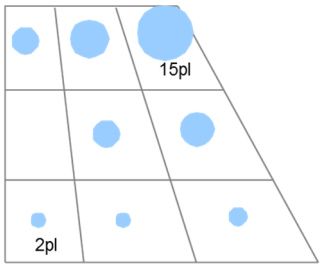

Fig.4 Image of M-dot technology

Supplies for RICOH Pro VC60000

For supplies in this printer, we divide its functionality into three, that is, (1) creating images on the paper surface with Quick Drying Ink (QDI), (2) fixing the ink droplet on the paper surface with Under Coat Liquid (UCL) and (3) protecting the image surface from smearing with Protector Coat Liquid (PCL) [5]. Fig. 5 describes the whole process of imaging on this type of paper on VC60000.

We succeeded in obtaining good print quality on offset coated paper by introducing especially UCL and PCL. Each functionality is mentioned below.

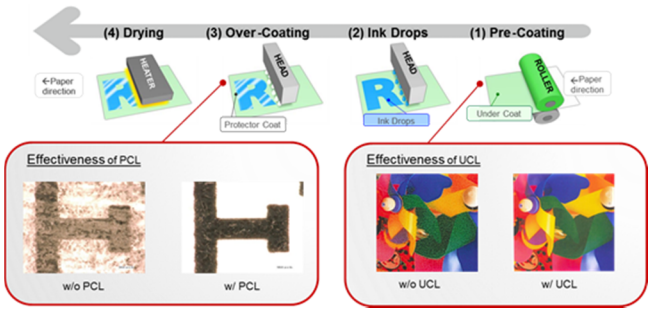

Fig.5 Process of imaging on VC60000

Quick Drying Ink (QDI)

Fast printing on many kinds of paper requires to dry ink quickly and this concept was developed in GELJET technology, which viscosity of the ink can be managed as the contents in the ink evaporating. However, the quicker the viscosity increases, the harder the nozzle condition can be maintained, therefore consistency between capability of quick-drying and reliability of jetting stability has to be considered for QDI. We carefully selected the humectants for QDI and improved its jetting stability more than conventional ink for GELGET. Fig. 6 shows the viscosity response as evaporating the contents in the ink, comparing with conventional GELJET ink. We can control drying property with managing to raise viscosity more slowly than GELJET ink.

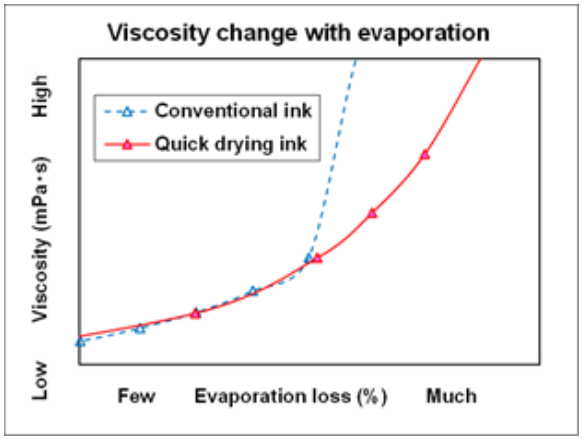

Fig.6 Viscosity response for each Ink set

Under-Coat Liquid (UCL)

When printing especially on offset coated paper, it is very difficult to keep the droplet shape round circle on the paper surface and place the ink droplet on the correct position since ink no longer penetrates into this kind of paper, therefore, graininess would not be accepted unless the droplet is forced to fix on the paper surface. Fig. 7 describes how Under-Coat works for the ink on the paper surface.

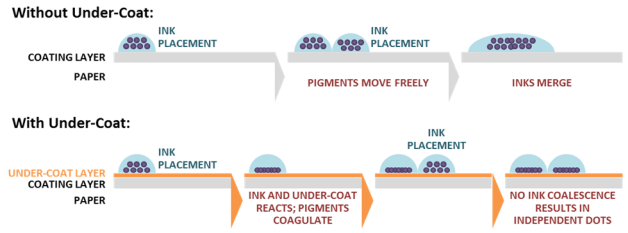

Fig.7 Function of UCL

If there is no Under-Coat layer on offset coated paper, ink would move freely and merge with adjacent droplet. This will cause Beading. On the other hand, if the surface of the paper has Under-Coat layer, UCL will neutralize the charge of the pigment dispersions and coagulate pigment so that it can keep the droplet circle and place it on the correct position. This functionality will prevent Beading.

We found the correlation between cationic strength of Under-Coat Liquid and image quality (especially Beading) in Fig. 8. According to this study, it is very important to manage the cationic strength in the ink in order to avoid Beading.

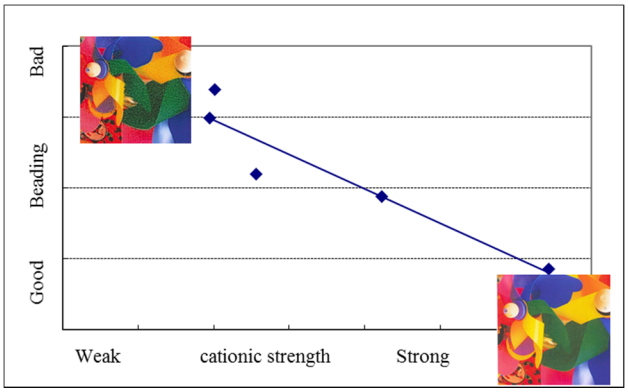

Fig.8 Correlation between cationic strength and Beading level

Protector Coat Liquid (PCL)

Even though the droplet is kept circle sufficiently and placed on the right position with UCL, it could be peeled off easily from the paper surface of offset coated paper when friction applies the image surface. Protector Coat Liquid was designed to prevent from this smear problem by filming the surface with its lubricant and resin. Fig. 9 describes the concept of forming film on the surface of the paper.

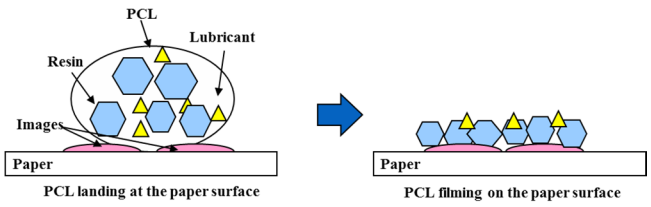

Fig.9 Concept of filming on paper surface

What is important for PCL is having the two properties, forming films on the images right after landing at paper and reducing surface energy. We introduced resin that has minimum film forming temperature (MFT), which is lower than the room temperature, so that it can form film quickly. Also, lubricant has the ability of reducing surface energy so the PCL can have smear resistance.

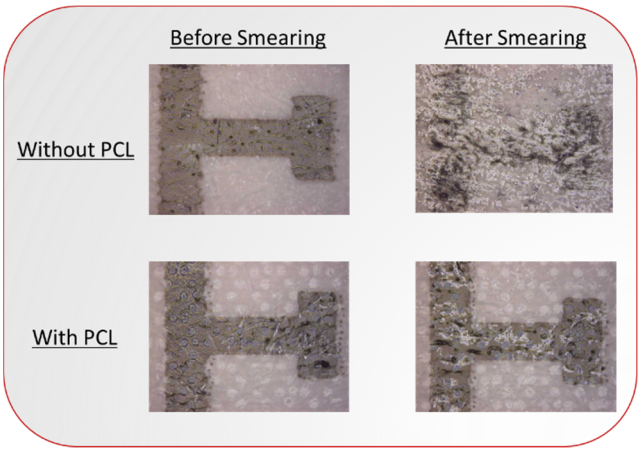

Fig.10 Before and after smear testing w/ and w/o PCL

Fig. 10 shows the result of smear testing on both with PCL and without PCL. Both images were rubbed with the same strength and found the image with PCL was preserved successfully, on the other hand, the image without PCL devastatingly deteriorated.

Strong Dryer Unit for VC60000

Drying unit is also very important for fusing images onto the paper surface. Especially on offset coated paper, as mentioned above, it is harder to dry due to its penetration property of ink than plain paper. Therefore, we have to take care about conducting heat effectively to paper, on the other hand, the heating energy has to be reduced as much as possible, from the power consumption point of view.

We introduced not only a big heat drum but also an air knife for the dryer unit so that it can dry and fuse image forming liquids that are mentioned above on offset coated paper effectively. Fig. 11 shows the dryer configuration of VC60000.

We put the main heat drum that can raise temperature up to 100 degree Celsius at the center of the unit and put five air knives around the drum. One air knife unit has two nozzles ejecting hot air, which is able to set up to 100 degree Celsius. Also, some of the hot air from the dryer is circulated in the unit in order to reduce the power consumption dramatically.

Also, air knives unit can be removed for those are printing transaction application only on plain paper.

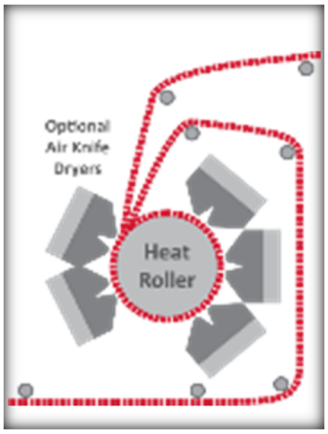

Fig.11 Dryer configuration of VC60000

Outcomes and future works of VC60000

We achieved good print quality on offset coated paper at 50mpm by introducing the newly developed supplies and the dryer unit. However, printing at faster speed and loading more ink for image expression from the marketplace would be expected. Therefore, we keep improving the key technologies for the future products.

References

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Author Biography

Shinta Moriya has been working for Ricoh Company Ltd. for eleven years after received a M.S. degree in Chemistry from The University of Tokyo. He had been working on developing maintenance sequence to maintain the nozzle condition reliable on small desk top inkjet printers for first five years. He is currently focusing on not only designing the system of optimized print process for continuous form inkjet printers but also on color science for commercial printers as future products from Ricoh.