Challenges faced by digital printing industry

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The digital printing technology is advancing rapidly as well as facing new challenges to meet the market requirements. These can be summarized as follows: Cost, ease of technology, nozzles, training of personnel, heads and pigment printing.

Cost

The cost of this technique is the main hindrance in the advancement of this technology because existing techniques available in the market are a much cheaper option as compare to digital printing. However, this sector offers a lot of attraction, especially for the high-end market.

The nearest comparison is the flatbed printing technique, which offers dyes and chemical cost of Rs.15 per sq/m with reactive dyes while digital printing ink will cost about Rs. 75 per sq/m. The cost of capital is also very high. However, in the near future, the cost is going to come down and replaceable parts become more affordable. This coupled with the speed of the machine will force the printers to replace even rotary printing machines. The main consumables contributing to cost in this technique are the print heads, other than ink cost. So the development of durable heads, with a long life, is a prerequisite to reducing cost in the long run.

Ease of technology

In the past five years, the techniques have improved but still, it has not reached the stage where it can outclass the conventional techniques available in the market. In the single-pass technique, grey and solid blotches need improvements. Heads require new dimensions and hardware techniques. Pigment printing needs to be addressed in depth as this will create a revolution in the field of textile printing as 85% of conventional printing is still performed with pigments. Pigment inks need to pass through an extensive R&D cycle. Possibilities could be a development of a block polymer of polyurethane and acrylate or incorporation of a positive charge on textiles may improve the adhesion of the pigment.

Nozzles

The nozzles need to be modified specially for pigment printing as the size of pigments particles is bigger than dyestuff, therefore they can easily clog nozzles. It is paramount that the size of the pigment particle must be reduced, without impairing aesthetic properties. For example, the main problem faced by reducing the particle size to below 1 micron is the reduction of colour yield and brilliance of shade. Success is only thus achievable if pigment chemistry and nozzle engineering are addressed simultaneously. The auxiliaries, such as solubilizing agents may play an important part in pigment inks in time to come.

Training of Personnel

The training regarding repair and maintenance of machines and hardware is going to play a very vital role in promoting this technique. To face these challenges, one must have knowledge of different mechanisms and the parts of the machines.

The digital textiles printers were introduced in the 1980s, and by early 1990s, the prices become more affordable, thereby attracting the conventional textile printing market for commercial printing. Apart from the price there are positive and negative aspects which can be summarized below:

- The level of flexibility varies from warp to weft.
- Different varieties of synthetic fibres and their compatibility with various dyes, which gives the problem of changing inks and also effects the performance of heads.
- Behaviour of stretch fabrics, highly porous and textured surfaces.
- Fastness properties of the prints.
- The designs need to be developed for the digital format.
- The design and colour management software, inks, fabric pretreatment, post-treatment and all the operations are important factors.
- The lower energy, water, short runs, total elimination of screens, less space, material consumption, and environment are positive points.

In case of the digital printer, the liquid ink in various colours is ejected onto the textile without actually touching, thereby, printing a high-resolution image. A printhead scans the fabric in horizontal stripes by moving left to right and back again while the fabric is rolled up in vertical steps.

The drops that are ejected are a submicron size which is much smaller than the diameter of human hair. One sq. meter of print may contains over 20 billion droplets; Positioning has to be very precise to achieve resolutions as fine as 1400x1400 Dots Per Inch (DPI). The resolutions and number of heads describe the speed of the machine; this can only be achieved by using the inks prepared by Nanotechnology.

Heads

There are two types of head technologies used when it comes to ink jet printers. The CIJ continuous inkjet or DOD drop on demand.

In continuous ink jet, the droplets are generated continuously with an electric charge imparted to them. The charged droplets are ejected from a nozzle.

The charged droplets are either directed to the textile for printing or they are directed to a recycling system. Since the droplets are generated continuously they are directed to the textile only when and where a dot is desired. The Hertz CIJ was the basis of the first commercially available digital textile printing system introduced by Stork (Now SPGPrints) in 1991 using Osiris "Iris" printhead technology. In DOD system the ink is ejected from the printhead only when needed.

In DOD the heads are driven by Piezoelectric system PIJ, where the ink is forced from the print head by a Piezoelectric actuator by a squeezing mechanism, or by a thermal mechanism. In this system, an electric heater inside each nozzle is used to rapidly increase the temperature of the ink which causes a vapour bubble to expand and allow for ejection of an ink droplet.

Ink jet printer heads and their technology

The most common inkjet printers head used in the present popular digital textile printing machines are as follow:

- Epson DX5 (Mutoh RJ900, Mimaki JV33, Mimaki JV5).
- Epson DX7 (Mutoh 1683, Roland XF. 640).
- Seiko 508 GS (FlexJS- BT-180, Ichinose 2030).
- Ricoh Gen. 4 (d.gen Telieios Grande, Mimaki TX 400).
- Ricoh Gen 5 (Mimaki TX 500).
- Konica KM512 (Konica Minolta Nassenger vii).
- Kyocera Kj4B (MS JP6, MS LaRIO, EFI Reggiani ReNoir).
- Precision Core (MEMS) Technology.
- Fuji Samba (MEMS).
- Zaar 5501.

The difference in the print head technology comes from the configuration of different Print head such as:

Print head width: The width of Print head varies from 25 mm to 108 mm. A large print head increases the speed of the machine by displacing more fabric on each scan of print carriage. Also speed can be enhanced by increasing the number of PH's.

Channels and Nozzles: The Print head has different configuration of channel to accommodate different inks. Each channel has specific nozzles which affects the printing resolution as nozzle density can be as high as 2048 per 43mm PH as in the Fuji Print Heads deployed by SPGPrints.

Frequency (KHz): The number of drops per seconds, directly impacts printing speed.

Minimum drop size (Picolitre): The print heads are capable of producing variable drop sizes, small drop size provide finer details at the expense of printing speed.

Binary versus greyscale

The size of individual ink drops directly affects overall output quality. In general, small drops produce good definition and higher resolution and suited for textiles' while large drops cover large areas quickly and are good for printing large flat areas. Many printers take the binary approach with every drop being the same size because it is faster.

The alternative is to vary the size of ink drops, a technique is usually known as grey scale printing. There are a number of advantages to this such as mixing smaller and bigger drops make it easier to deal with gradients and slight tonal shifts. In addition to softer tonal gradients, fuel consumption has also economized because small droplets give a higher print coverage, and reduce dithering.

There are three basic approaches. The first one is actually firing different size by varying the electrical power used to generate the drops.

Secondly, one can fire a very heavy drop of ink, which will stretch out as it flies through the air and break apart into larger and smaller droplets.

Third and the latest alternative is known as multipulsing and involves quickly firing two drops of ink that then merge into a single larger drop, usually in flight before they hit the substrate.

Mostly print heads use a combination approach. To calculate the print head productivity we can apply the Ross Allen of Hewlett Packard equation. Where,
A= Area fills rate. (inches per second)
N= Nozzles.
F= Drop rates. (Hertz)
R= Print resolutions. (dpi)

However it indicates the problem of resolution if you double the resolutions from 360 to 720 and keep the frequency and number of the nozzles same, the productivity reduces by a factor of four.

The mechanism of printing depends on two principles, multi-pass or scanning and single-pass Scanning.

Multiple pass: In multi-pass or scanning the fabric is held stationary as the carriage traverses across the width of the fabric, and once it reaches back to its starting position, the fabric moves forward one step.

Single pass: In a single pass, print heads are mounted over the full width of the fabric, one bar of stacked print head per colour, fabric moves with constant speed under these bars. The image is built upon vertical lines.

MS Lario is the commercial example of this system, Pike of SPGPrints, launched at ITMA 2015 is also coming up in the Pakistani market. Durst, Mimaki, EFI Reggiani are also getting a share. Kornit has showcased their latest version in Fespa 2018.

The scope of digital printer is very promising as the cost of heads and ink is likely to reduce appreciably as well as the technique will improve which will attract the printer to adopt it as soon as possible. Pakistan market is a bit slow to adopt this technique as they are printing mostly on cheap substrates, the only local market is supporting the cost. Market trends show that sooner or later, it is bound to flood the printing market.

References

DR. John Frost, SPGPrints, MS Lario, Durst and Vincet Cahills.◆