

Part One

Pros and Cons of Inkjet Technology

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Pros and Cons of Inkjet Technology in Industrial Inkjet Printing

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During the recent decade, inkjet technology has made large inroads into the industrial domain.

Fairs like DRUPA, Fesba, Drinktech, and many more demonstrate the strong advance of digital and specifically of industrial inkjet printing. In fact, inkjet has become a mature technology for graphical applications. Even in functional printing like printed electronics, 3D, and bio/pharma/medical applications, there have been successful implementations of inkjet technology.

The potential user of inkjet technology will find it useful in assessing the pros and cons of inkjet technology. We have, therefore, compiled here the views of the contributors of this handbook and have listed the advantages as well as disadvantages of inkjet, which still need improvement. Pros of inkjet technology:

- No physical print form needed, thus saving cost and time for machine setup (color management; RIP) in comparison with analog printers.
- Limitless design possibilities, along with immediate transition from one design to another and much lower capital associated with the design creation process.
- High flexibility – lot size 1 is possible.
- High productivity, fast investment payback, and less time to market.
- Maintenance costs of digital is lower as being a noncontact technology (says a Décor printer).
- Noncontact printing: important for rough surfaces, contoured surfaces, as well as mechanically sensitive substrates; adaptability to any surface, when combined with appropriate surface pretreatment.
- “Direct-to-shape”/“direct-to-object” printing onto contoured substrates.
- Scalable print quality (print resolution and grayscale printing).
- Less waste of often valuable inks (particularly functional inks).
- Lower consumption of inks.
- Precise control of deposited volume of functional inks.
- Printing of large substrate sizes possible with relatively compact machines.

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- Technology is suitable for a variety of production scales (from prototypes to production-scale machines).
- When presses run – then impressive print quality (says a label printer).

Cons of inkjet technology:

- Expensive inks.
- More sensitive to the interaction between the ink and the substrate.
- Limited layer thickness in single-pass printing (lower than, for example, screen printing).
- Fluids' viscosity limit lower than for, for example, screen printing.
- Inkjet is still a young technique with limited experience on the life span of inkjet machines, compared to demonstrated life spans of 10–20 years for analog printing machines.
- Few (no) low-migration UV inks yet available (says a label printer).
- Achilles' heel are lost nozzles.
- Artifact handling still trial and error for, for example, white lines, density unevenness (says a label printer).
- Digital printing is software intensive and the operators must be well educated.

The goal of this handbook is to provide all the advantageous features of inkjet to the reader and to address solutions for the challenges exemplified by the “cons” above. It is obvious that a close cooperation of technology experts throughout the field is paramount for the development and implementation of industrial inkjet applications in a fast and successful fashion.

In the following chapters, we will discuss whether or not inkjet is the appropriate technology for specific applications, and we will also compare inkjet with competing analog technologies.

We conclude this chapter with an example of a successful introduction of inkjet technology into industry. Alberto Annovi from TecnoFerrari describes the transfer of the decoration of ceramic tiles from analog screen printing to digital inkjet printing:

At the time when the first tile was printed by an inkjet printer (Spain, 1998), the ceramic tile industry almost exclusively used the well-established screen printing technique for the tile decoration process.

The competition at that time was mainly on prices, which prompted the major manufacturers to adopt a “big volumes model” with bigger and bigger batches and to save cost by way of developing their own inks internally. Small ceramic tile manufacturers with their low volumes therefore had difficulties to enter or be competitive in the market.

In this scenario, the first inkjet applications were not really successful: The possibility of obtaining high-resolution designs and a good gamut starting from just a few colors (CMYK) were not compensating for the poor reliability of the available printers in such difficult manufacturing environment and the high cost for the printers and the inks. A further technical problem was the limited color fastness of the inks during high-temperature postprocessing of the tiles.

However, the advance of oil-based pigmented inks in 2006 changed the situation: Their cost was significantly lower, their thermal stability and color

fastness were much higher, and the jetting process was of higher reliability. More printhead manufacturers entered the market, thus adding competition and reducing the printer prices.

A further move toward inkjet was the 2008 crisis, which impacted the ceramic tile market and specifically hit the major manufacturers, because their “big volumes model” was no longer efficient.

Small factories were now able to buy inkjet printers and started to be competitive in the market since the cost of inkjet technology (printers, printheads, and inks) was essentially the same for everyone. It was neither possible nor cost-effective even for the major manufacturers to develop an inkjet printer or an ink internally.

In parallel, some new developments in presses, glazers, and packaging were made that enabled the production of bigger tile sizes (over 60 cm), and noncontact inkjet printing thus became advantageous over a screen/roller, pushing a big thin tile passing over two belts.

In the past 8 years, inkjet printing has grown fast to become the dominant technique, thanks to strong competition between manufacturers of printheads, inks, and printer machines. Nowadays, inkjet technology has almost saturated the ceramic tile manufacturing (in some countries like Italy and Spain, more than 95% of production lines are digitalized), but still there are few thousands production lines to populate with new printers worldwide.

The challenge now for a ceramic tile manufacturer is to design a new product faster than his competitor and to create greater diversification by mixing press, roller, and inkjet printing.

The tile size has increased recently, and now it is possible to produce big slabs (over 200 cm) and their decoration process can only be inkjetted.

The inkjet technology is still unable to produce a good “materic effect” (surface structure and 3D effect) due to limited particle sizes that can be jetted. This is why tiles printed by inkjet are sometimes considered “flat” compared to those produced with conventional screen printing. To produce “materic” effect by way of inkjet printing or by hybrid techniques of inkjet and analog techniques is therefore a “new frontier” in inkjet development for ceramic tile manufacturing. See TecnoFerrari’s chapter 45 (paragraph 3.2) for details on this further technology step.

And some inkjet “pros and cons” specific for the decoration of ceramic tiles:

Inkjet pros:

- Efficient production with small batches
- High productivity
- Fast investment payback
- Less time to market
- High-quality designs (resolution, grayscale, drop size)
- Design randomization

Inkjet cons:

- Sensibility to analog process fluctuations (glazes, kiln, etc.)
- Difficult for the ceramic industry to manage the “technology” (printheads, inks)

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- Limited materic effect
- Added costs for working reliably in ceramic environment
- Limitation in jetting big particle size glazes and aqueous-based inks
- Operators need to have skills in electronics, software, and graphics.

For further information regarding the comparison between inkjet and screen technology, see Chapter 2.