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PRINTERS' GUIDE
Training Information & News in Printing and Paper Converting Technology

Digital printing

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1. Overview and distinctive features in comparison with conventional printing methods
2. Electrophotography
3. Inkjet printing
4. Marketing in digital printing, applications, future prospects of digital printing

For industrial print production, above all electrophotography (colloquially called laser printing) and inkjet printing are of key of importance.
In the early years of digital printing, electrophotography was assumed to have better development and market chances, but by now inkjet printing has caught up thanks to dedicated development work, especially as far as inks, the jets and higher speeds are concerned.

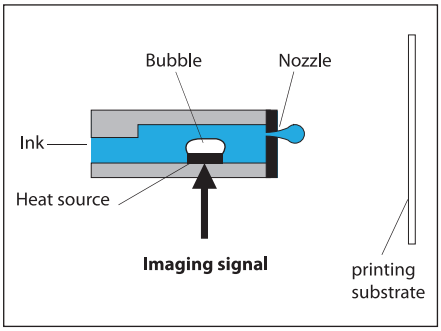

Figure 1: Thermal inkjet

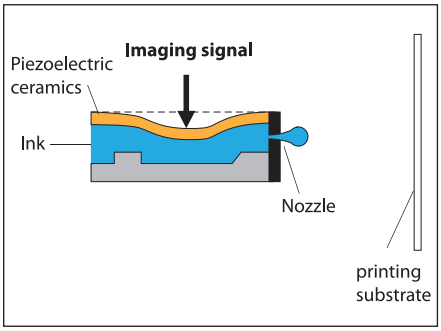

Figure 2: Piezo inkjet

Inkjet printing is based on a jet system from which mostly liquid ink is sprayed onto the substrate in single drops. The difference between the continuous tones is achieved by the drop being different in size or by printing several small droplets on top of each other.
The drops can be produced in the jet in two different ways:
1. Bubble jet / Thermal inkjet
A heating element in the jet is strongly heated for a short time, thus produces a gas bubble that is ejected from the jet due to its increased volume. When the bubble bursts, a vacuum is created which sucks a further amount of ink from a storage container in the jet.
2. Piezo inkjet
A characteristic of Piezo crystals is that they deform under electrical voltage. Due to this deformation of the piezo ceramics in the jet, the ink channel is contracted and ink is ejected. Due to the capillary effect in the jet, the ink channel will subsequently fill again.
(See Figures 1 and 2)
A comparison of these two types shows the following:
Bubble jet: The production costs of the jets are lower which makes this printer more favourable as far as purchasing is concerned, it is, however, slower in the production of drops due to the thermal principle (5000-8000 Hertz), and, in addition, more prone to malfunction. As a preventive measure of the malfunction of the heating element, the complete printing head is replaced with every ink replacement. As a result, these systems are expensive to maintain. The inks must be heat-resistant.
This method is used, e.g., in devices from Canon or Lexmark.
Piezo jet: Due to the piezo-electrical principle, these printers are quicker with regard to drop production (12,000-25,000 Hertz) and have a substantially longer service life of the jets; normally only the ink cartridges need to be replaced. On the other hand, these printers are expensive.
In addition, a distinction is made between **drop-on-demand** and the **continuous** ejection principle.
Drop-on-demand: Drops are only ejected from the jet if dots need to be produced. The drops may be produced by means of the thermal or piezo methods.
Continuous ejection principle: As can be seen from this term, drops are ejected from the jet continuously, i.e., permanently. The drops that are not required are mostly transferred back into the ink circuit. The deflection can be made in different ways, e.g. by means of deflecting electrodes, magnetic fields, directed air flow, drop collision or oscillating jets.
For binary deflection, there are only two states of charging. Drops that are not needed are electrically charged and deflected; the others reach the substrate.
For multiple deflection, the drops reach the paper at different places by means of different charge conditions so that it is possible to print lines at a height of up to 10mm via a jet.
(See Figures 3 and 4 on page 16)
With respect to the inks, see Figure 5 on page 16.

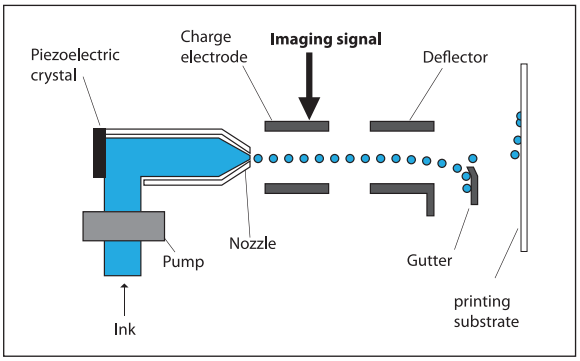

Figure 3: Continuous inkjet, binary deflection

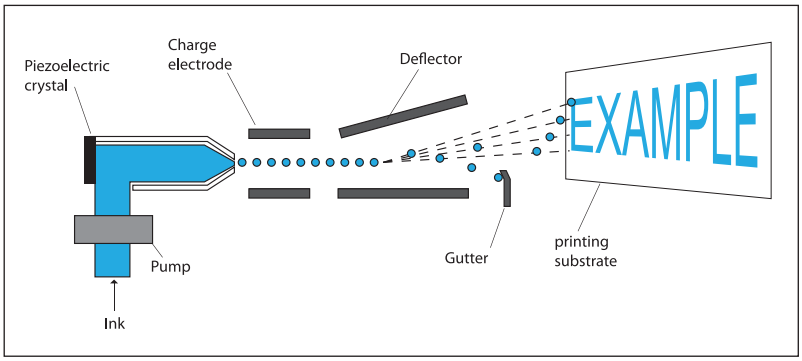

Figure 4: Continuous inkjet, multiple deflection

Inks always consist of colorants, which actually produce the colour, and a carrier liquid (binding agent) for the transport of the colorant.

Colouring substances may be dyes or pigments, the binding agents may be water, oil or solvent.

Water-based colour inks are used for indoor purposes. They have a larger colour space, but fade more quickly under the impact of UV.

Water-based pigment inks are more stable as far as UV is concerned. Pigments, however, have a smaller colour space; they appear to be somewhat duller, matter and have a less brilliant effect.

Oil-based inks are pigment inks with an oil-based binding agent. On the one hand, their UV stability is higher; the jets do not dry so fast during longer idle times. The disadvantage is that they require special substrates that do not absorb the oily binding agent so quickly. Therefore, the dominating method for outdoor applications is the solvent-based ink.

EcoSolvent inks are inks with a low solvent content that can also be used without an extraction system being required. Their UV stability is good, the abrasion resistance, however, is restricted and the inks dry slowly.

Normal solvent-based inks are the inks with the highest UV stability for outdoor applications (3 years and longer) and a short drying time. They can be used to print on nearly all substrates without any special coating. However, an extraction or air filtering system are necessary due to the solvent content.

Like UV printing inks, **UV inkjet inks** dry by means of radiation curing with UV light. As a result, the printed materials can be processed immediately. The number of possible applications is huge – UV curing inks can, e.g., be used to print displays, signs, banners, laminate floorings, packages, stage graphics, lettering on vehicles as well as photos in good quality. As far as environment-friendliness is concerned, UV curing inks do not release hazardous VOCs during the printing process in contrast to, e.g., solvent containing inks. On the other hand, during the curing process with the normally used UV mercury arc lamps ozone is produced which is hazardous to human health as well as due to its oxidising effect. They can be substituted by LED lamps.

Hot-melt inks consist of a mixture of resin, oils and wax into which the pigments are fused. The wax melts due to the heat, and the ink becomes liquid. One disadvantage is that the electricity costs are high.

In addition, the inks must contain different additives. They are needed for aspects like adhesion of the ink on the substrate, dot gain, dot generation, corrosion of the printing head, resistance to fading or colour brilliance.

With regard to technology and field of application, the following groups can be defined:

1. Office and desktop devices
   Simple, inexpensive printers, often bubble-jet technology, water-based inks
2. Proof printers, photo printers
   For contract proofs, printing in photo quality, high-quality promotional material with personalisation, mostly size A3+, very high resolution, colour stability, prepared for colour management software
3. Large-format printers (LFP) are used to print posters, banners, stand-up displays, textiles; special format flatbed printers that can print plates up to a height of 6-8cm (construction signs, exhibition walls, furniture plates, etc.), with solvent-based or UV inks
4. Illustration printers, mostly web-fed machines (trans-promotional printers) for medium and long runs of personalised advertising, direct mail, book printing (book-on-demand), book on a variety of papers is possible, at a quality level near to web fed printing, for industrial inkjet printing; example: KBA RotaJET, see Figure 6.

Figure 6: KBA RotaJET 76

5. Addressing units/Inkjet units in hybrid machines
   Smaller inkjet units with a low width, high performance, medium to high resolution, for personalizing, address imprinting, printing of best before dates, prices, imprinting of highly topical news and other variable data.

This variety of fields of applications across the total printing industry shows the great potential of inkjet printing. A big advantage is that it is a non-contact printing method, i.e., the jet and the substrate are not in direct contact with each other. As a result, it is possible to print on a large number of surfaces and materials, even shaped objects, directly.

Trends in inkjet printing are:

- 6-/8- or more colours (+light cyan, +light magenta, spot colours, photo black, white base, metallic inks, hexachrome ...)
- Drop modulation (variable drop size)
- Printing heads along the total width of the page
- A multitude of colours for a wide variety of materials, food-safe inks, ...
- Cost-favourable production of printing heads
- Nanographic inks.

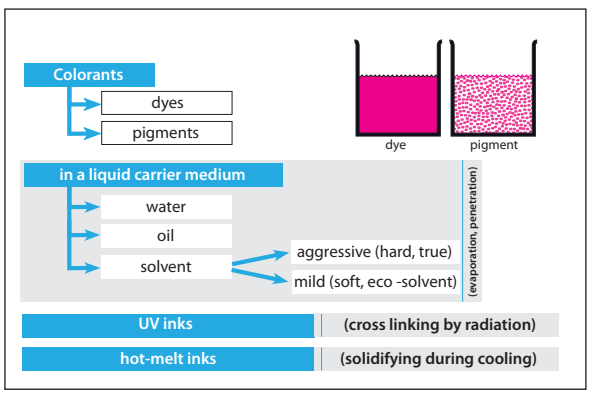

Figure 5: Inks for inkjet