DIGITAL PRINTING

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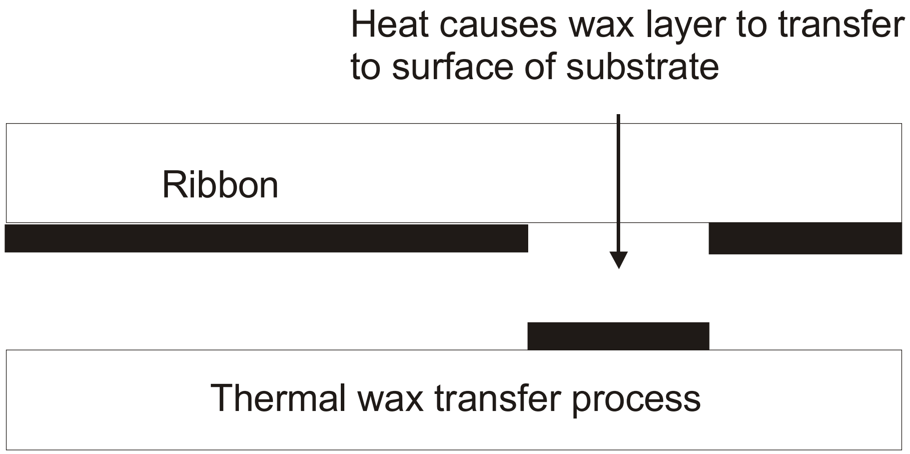
THERMAL TRANSFER PROCESS

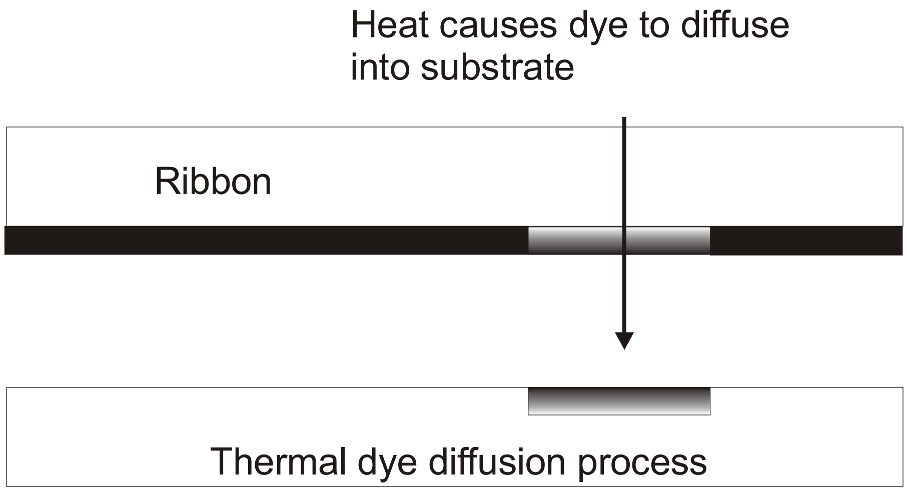
As the name suggests the thermal transfer process uses a thermal array to transfer colour that is a mixture of resins and pigments or dyes from a carrier ribbon onto the substrate. The alternative uses a Laser to create the pulses of heat that transfer the colour. In its simplest terms the creation of an image using thermal transfer are the iron on transfers used for decorating textiles. When decorating objects the traditional hot foil or foil blocking are the analogue versions of this digital concept.

A simple application of the thermal transfer process is single colour printing of bar codes where edge definition and density of colour is important along with reasonable speed. This is used primarily in print on demand label applications. Printing of more complex near photographic quality images is eminently possible. The quality of image required will determine the mechanisms that are used. The process can be further divided by printing directly on the substrate or first printing onto a carrier and then transferring from that flexible carrier onto a flat or slightly contoured substrate.

The two transfer processes are Thermal Wax and Thermal Dye Diffusion.

THERMAL TRANSFER PROCESS





Thermal wax transfer is the simplest but it does not give the range colour that is possible from Dye Diffusion. The configuration of the thermal transfer heads are very similar, the main difference being the transfer ribbon that is used. The thermal array is a series of minute heaters typically 300 per linear inch these operate independently along the length of the array applying heat through the carrier ribbon when the array is pressed onto the back of the ribbon. The imaging software determines which elements of the array are heated whilst the ribbon and the substrate are indexed underneath. This process is relatively slow and is only suitable for low volume or proofing applications. With thermal wax printing the intensity of colour for each point of contact remains constant whereas with dye sublimation it is possible to produce 16 concentrations of the colour by each element. The resulting colour image has as wide a colour gamut (range) as any printing process and is used for colour proofing. Full colour images are produced using Cyan, Magenta, Process Yellow and Process Black ribbons. It is possible to do without the Black, by using a combination of the other three colours but the finished result does not have the crispness of the four-colour image.

A thermal wax transfer printed image adheres to the substrate using heat activated adhesives within the formulation of the colour.

Dye diffusion is achieved by the dyes in the colour being heated by the elements in the array and turning to a gas which penetrates the substrate and colours it when it returns to its solid state.

The substrate has to be receptive, normally a polyester (or similar polymer) coating. In both cases the substrate has to be flat because any irregularities that will not be overcome by the pressure applied will not take the print.

Printing the full image onto a carrier film substrate can to some extent accommodate irregularities. This imaged carrier film is then fed through a traditional transfer application press and the image transferred to the target substrate using a heated non-rigid silicon rubber platen.

For applications such as this, the carrier film can have a heat activated lacquer that is transferred when the image is brought into contact with the target substrate. This lacquer provides additional protection for the colour, as it is not particularly abrasion resistant on its own.

Using a laser to generate the energy for the sublimation to take place is possible. In this case, the colour ribbon and the substrate are wrapped around a drum and then a scanning laser is deployed internally or externally to heat up points on the ribbon thus transferring to the substrate.

The resulting image can be made up of 3000 l.p.i., compared to the 300 l.p.i. with the conventional array.

This type of imaging is only applicable to decorating substrates that are flexible and can be wrapped around the drum. It is also possible to take the imaged substrate and use it as the transfer medium in traditional transfer application.

Ink Jet Processes

Ink jet printing was first used early in the 20th Century. It operated by firing droplets of ink onto a surface. These droplets were deflected by a magnetic field to form a matrix of dots onto a moving substrate. This system is still used and can be seen in a variety of applications from batch numbering automotive components to date coding eggs.

There are two types of ink jet printing. Continuous Ink Jet and Drop on Demand Ink Jet.

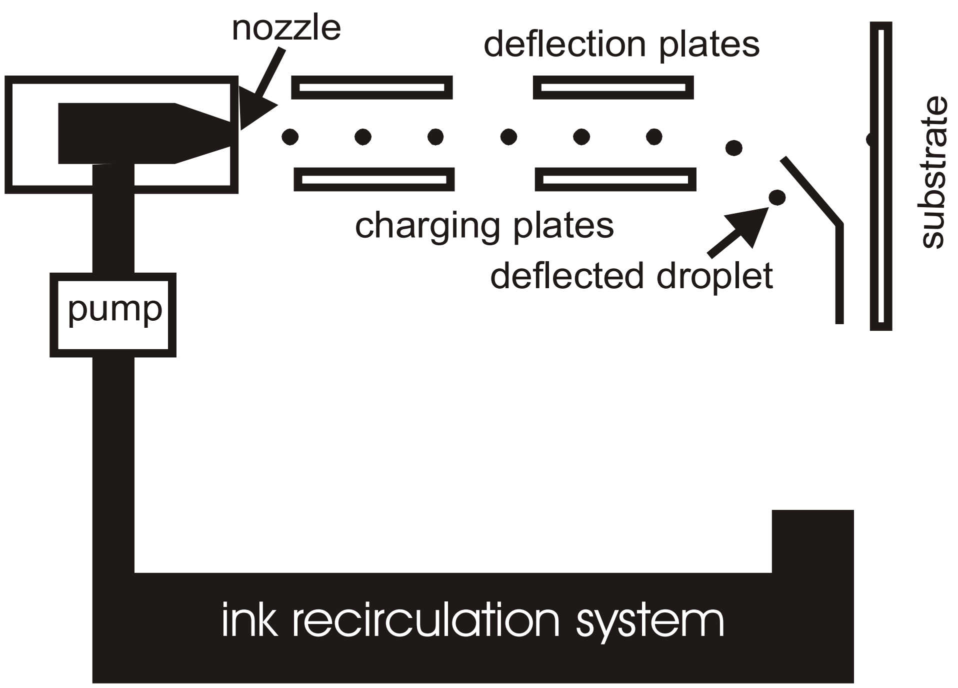
Continuous Ink Jet

This was the original form of ink jet printing. Ink is pumped through an orifice and then given an electrical charge that is then used to produce a deflection as it passes through deflection plates. The dots deflected are re-circulated whilst those not deflected carry onto the substrate.

Using this method it is possible to create simple designs on a moving substrate. More recently, the motive force is a piezoelectric crystal that vibrates at very high frequency producing hundreds of thousands of droplets every second.

These droplets are deflected as described before to form images on a substrate. Even with piezo devices, the image quality is restricted to simple text or low-resolution bar codes.

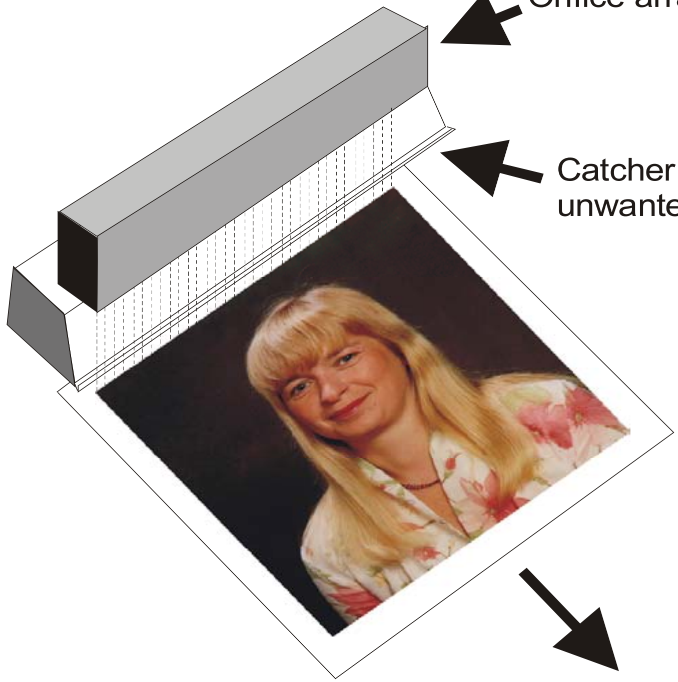
Continuous Ink Jet Printhead



CONTINUOUS ARRAY INK JET

The quality of print obtained by continuous ink jet is a limiting factor. To improve this, nozzles are lined up in a row. It is even possible to put two rows together. There would be 240 per inch on each row and each orifice would have a discrete electrode that can deflect any or all of the droplets exiting from the orifice. The droplets are emerging at between 50,000 and 100,000 droplets per second. The very high rate that these droplets are produced mean that the rate of print can be as high as 500 feet per minute. This results in an image quality that is slightly less than the lower end laser printers. Quality is compromised by the effect of the wet ink hitting the substrate at speed and splashing on the surface. Resolution is not expected to improve to more than 300 dpi, as the bulk of the mechanism will restrict the degree of miniaturisation that is possible. It is possible to direct individual droplets to a specific point on the surface. This can have the effect of varying the individual printed dot size that in turn provides a vast improvement in image quality.

CONTINUOUS ARRAY INK JET



This can take the process into four-colour printing. The major limiting factor when it comes to printing onto packaging and allied substrates is the need to use dye based inks which are effected by UV light. This means that printed images have to be laminated with a UV protective film.

Drop On Demand Ink Jet Processes

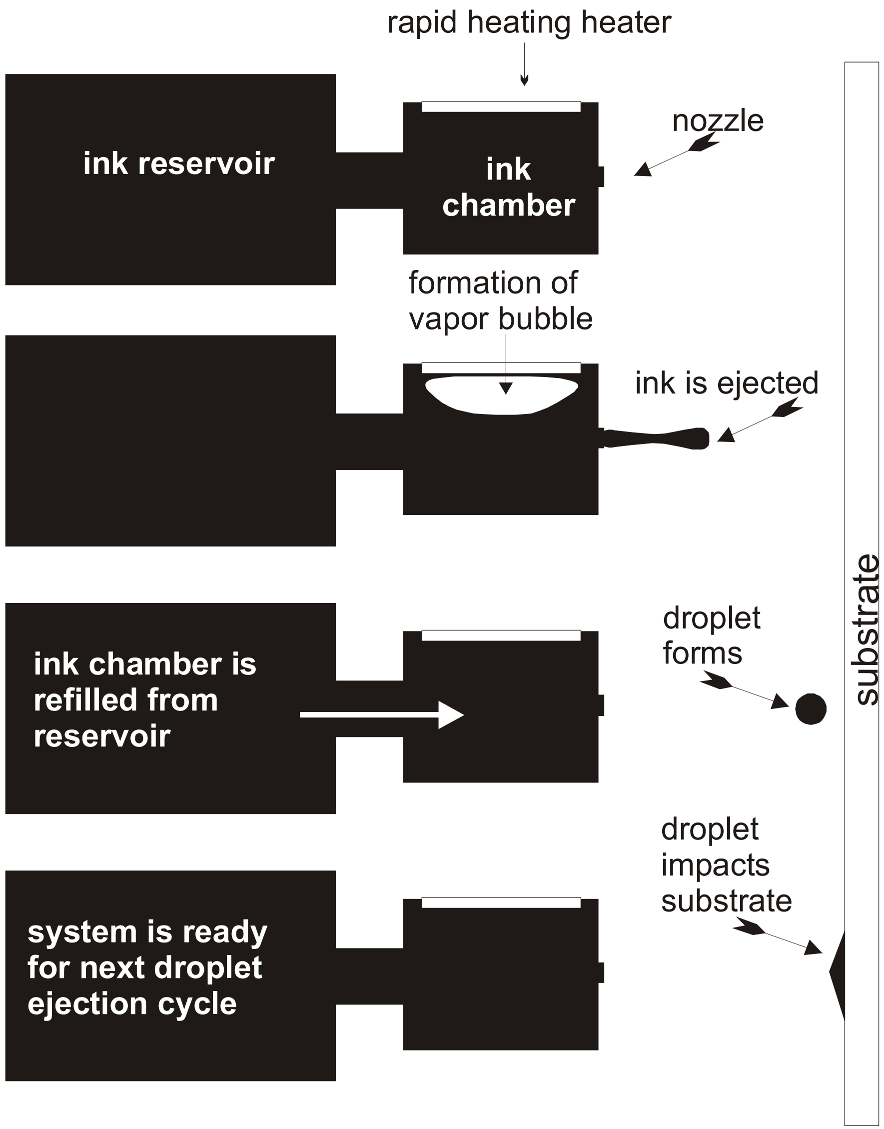
These are the processes that are the most suitable for use in the market to which this section is addressed. In these processes, ink is ejected from very small orifices directly onto the substrate to be printed. Areas where there is no image have no ink directed onto them.

There are two ejection mechanisms heat and piezo. Heat is the most common but piezo gives the opportunity to use the widest range of materials in the ink formulation.

Thermal Ink Jet

For thermal ink jet the ink system needs to be water based. The ink passes from a reservoir into the ink chamber. A heating element heats the ink rapidly and forms a bubble of water vapour. This bubble in the chamber forces the ink through the orifice and it forms a droplet the droplet impacts on the substrate. The chamber has then to be refilled before the next droplet of ink can be ejected. This refilling process linked to the heating and cooling of the heating element means that the process is relatively slow.

Thermal Ink Jet Process

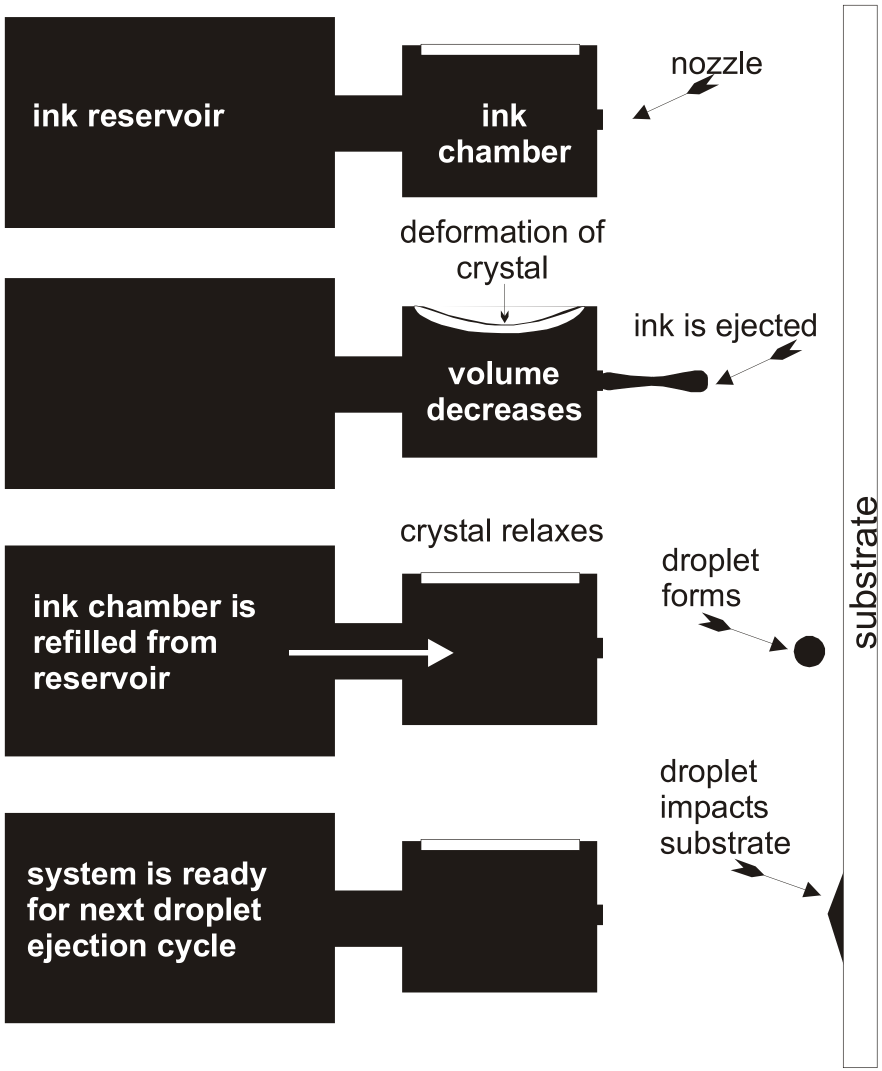


PIEZOELECTRIC INK JET

Instead of using a heating element to create a bubble in the ink it is also possible to alter the size of the ink jet chamber and effectively squeeze a droplet of ink out through the orifice. The chamber is constructed with one or more of the walls containing PZT (Lead Zirconate Titanates). The piezoelectric effect; where mechanical energy is converted into electrical energy, is well known. A common use is in a cigarette or gas grill lighter, where a lever applies a pressure to a piezo, inducing an electric field, which is strong enough to create a spark to ignite the fuel.

The reverse effect is used in ink jet heads. Here, an electric field applied to a piezo ceramic is used to produce precise motion. The most common form of piezo ceramic used today is a lead zirconate titanate based material. When an electric field is applied to a piezoelectric material, dipoles in the crystalline lattice orient themselves to produce expansion in the direction of the field. The precise configuration and operation of the ink jets is high science and Xaar of Cambridge are the world leaders in this technology.

PIEZOELECTRIC INK JET PROCESS



The big advantage of piezo technology is the range of materials that can be used as the printing medium. Developments are now allowing mediums as different as sublimation dyes to ceramic pigments to be processed through these devices. Another family of inks is what is known as phase change or solid ink jet printers. These start as solid wax and are heated in the reservoir to change them to a liquid. They then pass into the chamber where they are ejected by the piezo mechanism. Upon hitting the substrate, they freeze back to wax. This produces a very high quality image of intense colour. Unfortunately the ink film is not particularly scuff resistant so it is not suitable for handling unless a post curing process is used to create the bond between ink film and substrate. This is not to say that any conventional ink can be processed. The inks have to be very carefully engineered to deal with the characteristics of the process. These are the size of the orifice, which determines the solids particle size. The amount of work put into the ink, which will effect the viscosity and rheology. Temperature variations caused by the use of electrical energy and the movement of the piezo ceramic. If the ink is compatible with all these effects, it then has to bond with the substrate and withstand the working conditions.

Although piezo ink jet technology is the favoured method for ink with high solids content, print solutions have to be engineered as a whole.

Thermal ink jet printing heads are more compact than piezo which means that more thermal engines will fit in a small area resulting in higher speed than piezo print heads. Digital technology is very attractive and has many advantages but it does not have the degree of flexibility to deal with process variables to the same extent as screen printing which is the technique that will be competing in this area of the market.

In summary, these various systems have some common features. With the exception of the simplest ink jet process, they will all print multicolour images. The quality ranges from poor grade desktop print to high end proofing quality. Dye sublimation systems need a compatible substrate surface normally a form of polyester, either as a coating, a film or a woven textile. Ink jets that can print ink or mediums with solids content will adhere to a much wider range of substrates. Sometimes the ink film has to be protected by an additional coating. No one process provides solutions to all print applications.

ZUND UVJET FLATBED INKJET PRINTING MACHINE
COURTESY OF BP GRAPHICS LIMITED

INK TECHNOLOGY

Ink systems are improving all the time. Solvent based, Water based and Ultra Violet Curing systems are available where applicable for various processes. They are still very expensive when compared to conventional systems and it is unlikely that they will fall in price significantly, as it is the sales of ink where money is to be made. Head manufacturers will often have licensing agreements that ensure ongoing income and these have to be carried in the cost of the ink.

COMPETITION WITH OTHER PROCESSES

Salesmen have made claims that Digital Printing will print on to uneven surfaces. This is not the case. The limiting factor is the distance the ink drop will travel and still maintain its structure and direction. In all but the crudest systems this has to be less than a millimetre. Any further and definition is lost and quality goes. Where it can be used on uneven products is when used in In-Mould Decoration (IMD). Even here its effectiveness limited, as it has to be protected from the forces within the mould tool. An alternative is producing an image on a flexible film and forming polyester coating. This was a process that appeared to by revolutionary but it is slow and expensive.