

Technology & solutions for the direct printing of pots & tubs

In this special feature on the direct printing of pots and tubs, Lawrence Wild reviews the 'dry offset' process, printing technology, inks and product handling requirements for the decoration of injection moulded and thermoformed containers for the food, pharmaceutical, cosmetics, toiletries and industrial markets.

The dry offset printing process continues to be the most successful and universally used method for the high speed decoration of three-dimensional products by direct printing and is the only direct printing process where the complete and final multi-colour image is transferred onto the substrate with one single impression.

In the plastics industry, dry offset printing is the main process for the decoration of cups, pots and tubs, (injection moulded or thermoformed) used for the packaging of foodstuffs such as yoghurt, margarine, creams, salads etc as well as their prospective closures (lids).

Pre-formed tubes for cosmetics or toothpaste, vials for pharmaceuticals, cartridges for sealants, and buckets or pails for emulsion paints are high volume applications for dry offset printing.

Early use of dry offset however was initially, in the field of side wall decorating, extruded metal containers such as beverage cans, tubes and, more recently, monobloc aerosol cans and pilfer-proof closures for whisky bottles.

The main printing processes used in packaging today (litho, flexo, gravure, and screen) involve multiple impressions, whereby each colour of an image is printed onto the substrate consecutively and in register. These can be described as wet-on-wet processes, or with between colour drying, wet-on-dry. They can be in-line or multiple pass. Such an approach was not possible with early technology for direct printing onto three-dimensional containers which have awkward shapes and

varying dimensions, therefore a different approach was taken.

To transfer the final printed image in one single impression.

To transfer a wet, high-quality, multi-colour printed image with one impression onto a three dimensional container which could be round, square, rectangular or oval, and invariably had tapered walls, presented some tough challenges for the machine designer.

In 1944, two Swiss aluminium tube manufacturers inspired the engineering company WIFAG, Berne, to develop a printing machine for tubes. The prototype of this machine was supplied to Messrs. Sturm in Bischofszell, Switzerland, in 1945.

Hence the early toothpaste tubes were direct printed. In the early sixties, this printing process was developed further, for the decoration of plastic containers, lids and closures etc. and a new WIFAG factory (Polytype SA), opened in Fribourg.

Process theory: The only similarity of the dry offset process to offset lithography is in the fact that a rubber blanket is used to carry the image from the printing plate to the surface of the substrate (i.e. container). It should not be mistaken, however, for an offset system which merely eliminates the use of water to prevent ink transfer in the no-image areas.

The plates are in fact similar to a letterpress plate, having a positive raised area. In this respect the process could be called, indirect letterpress.

The last element of a dry offset printing unit is a blanket cylinder. This

is a common impression cylinder with a number of rubber blankets precisely affixed to it, generally by a double sided, adhesive tape. The blanket rotates past each printing plate cylinder, one after the other, building up the complete image (up to 9 colours) onto the single blanket. This complete image is then transferred, in one pass, directly onto the container side wall, or lid surface.

Printing unit: Each printing unit comprises an inking unit and a printing plate cylinder. As mentioned, up to nine such combinations are spaced consecutively around one side of the blanket cylinder.

Inking unit: The essential purpose of the inking unit is to generate an adjustable, thin, consistent layer of ink to the raised areas of the printing plate. The ink supply system comprises an ink fountain (reservoir). The metering of the ink is achieved by a doctor blade, adjusted by a series of metering screws, against a fountain roll not dissimilar to regular offset lithography. Similarly, the ink is transferred from the fountain roll to a series of oscillating rolls by a dab roll. The dab roll cycle is adjustable,



Printing machine for rectangular/square tubs



Printing machine for round pots/cups

depending on the quantity of ink which must be transferred to a series of oscillating, metering rolls which split down the ink layer. The inking train is completed by a number of rubber covered form rolls which ink up the printing plate.

Printing plate cylinder: The modern printing plate (e.g. Nyloprint) is made from a photo-polymer plastic, backed by zinc or steel plate. The plate thickness is nominally 0.73mm thick and the etching depth is in the region of 0.3 to 0.4mm. The production/development of the printing plate from the artwork to the colour separation, the screening, the exposure, etching etc is similar to the letterpress process used

on narrow web label printing presses.

More recently, developments have taken place with the Toray type of planographic printing plate. This particular approach, however, demands consistent and stable ambient conditions in terms of temperature control, and a dust-free environment. The current grades of plate tend to be short-lived, however they are relatively inexpensive. Several UK printers are pioneering this process.

The printing plates can be fixed to the cylinder by clamping bars or, for example, Nyloprint plates are precisely pre-punched in register with the image, and gripped on the cylinder, in register, with a pin gripper mechanism. In this way, since all the printing plate cylinders are geared in register with each other, the complete, multi-colour image is pre-registered before start up.

In the USA, magnetic cylinders are often used, eliminating the need for clamping or gripping mechanisms.

The printing plate cylinders can be individually fine-adjusted whilst in operation, for both lateral and longitudinal register.

Inks: Previous generations of inks

were thermally dried, either by hot air or IR (infrared) ovens or tunnels. The vast majority of plastic cups, tubs, lids and tubes today are dried by UV curing, either directly in the machine (see later explanation) or in a small UV curing oven.

The ink must be individually formulated to prevent back colouring and contamination of the inking units. What does this mean? Since one common blanket is inked up with all the colours consecutively in one pass, there is a danger that the image in the area of colour overlap will be picked off by the subsequent printing plate and transferred through to the inking train, resulting in back colouring.

With this in mind, the inks are fine-tuned to resist this possibility. During the rotating cycle of the blanket cylinder, the lighter colour images are printed onto the blanket first, progressing to the final colour, generally black, in the last printing unit, where colour overlap occurs. The lighter colours will have the higher green tack (i.e. resistance to be picked off the blanket) and the darker colours are smoother with a lower green tack level.

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This allows the blanket to retain the complete image.

Printing cycle & product handling: The peripheral equipment for the handling and transfer of the container throughout the printing cycle is designed specifically for the container design. Yoghurt pots or margarine tubs, for example, are tapered wall containers which readily stack inside each other.

Sticks of such containers are de-nested and automatically fed onto a rotating dial or spider which is fitted with a series of mandrels. The mandrels are manufactured to the same diameter and taper as the cup or pot. Each position on the dial represents a specific function during the rotation of the dial, which rotates in perfect register to the blanket cylinder, and stops intermittently at each function point. E.g. Functions: position 1 — feed on; position 2 — pre-treatment; position 3 — printing; position 4 — UV curing; position 5 — take-off. The mandrels are driven and rotate during the fraction of a second that the dial stops cycling.

The blanket cylinder can be adjusted to the mandrel at the Printing position, for both pressure and angle (according to the taper of the cup).

Pre-treatment position: With the majority of plastic materials it is necessary to treat the surface of the

container prior to printing, to achieve the necessary adhesion. This pre-treatment can be done either with a gas flame, or Corona discharge. The former is preferred for thick wall containers (e.g. injection moulded) and the latter for thinner wall products (e.g. thermoformed). A surface tension of around 40 — 42 dyns is preferred.

Printing position: The conditions at the printing position are important to achieve optimum image transfer. With tapered cups especially, the screen count of the printing plates must take into account the mean diameter of the cup, and be adjusted accordingly. The quality of the cup (e.g. consistency of wall thickness) can be accommodated to some extent by the compressibility and quality of the blanket chosen.

UV curing position: With round containers the inks are cured, whilst on mandrel, by a UV Lamp. The mandrel is driven to rotate several times under the lamp, to ensure full exposure and good cure. Rectangular containers are taken off mandrel, whilst wet, and cured in a UV tunnel.

Different types of lamp are available. For example when printing polystyrene foam cups, a so-called cold UV system is used, to prevent distortion or melting the cup.

Production speeds: The modern cup



Printing machine for lids (any shape)

printer for typically, yoghurt pots, will print up to 9 colours at speeds up to 600 cups/minute, depending on the shape of the cup and the complexity of the graphics. It is difficult to envisage direct printing onto a rectangular margarine container with a rotating blanket, but it is achieved, with images even around the corners. As with flexographic printing, dry offset has come a long way in the last decade. The threats from in-mould labelling, shrink sleeve, self-adhesive or wrap-around labelling etc, have failed to replace direct printing as the most cost-effective method of decorating containers.

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