REPLACING THE NEED FOR LABELS

Holly Steedman (Integration Technology) and Jochen Christiaens (Zeller+Gmelin), explore the integration of inkjet in coding and printing directly onto containers, eliminating the need for labels

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Labels containing single-line or data matrix barcodes are commonly used on boxes and containers in automatised logistic systems. However, inkjet printing has enabled printing directly onto plastic packaging, for late-stage customisation, without needing the boxes to leave standard manufacturing or supply chains. The in-house variable data printing creates added value by enabling various possibilities of printed designs.

Integration of inkjet printing in manufacturing environments is a successful and developing field. Major implementation application areas in industrial manufacturing are on the decoration of flat plastic surfaces for personalisation and serialisation. These solutions often replace labelling processes and open additional marketing features thanks to inkjet's flexibility.

Integrating in-line, inkjet-printing systems allows the printing and decoration of these plastic products using UV-LED inkjet printing. This solution shows great adhesion results on most common plastics such as polypropylene (PP) polythene (PE or PET), compared to many other substrates.

BOXES

Automatised logistics systems use practical, transformable large-volume pallet boxes and standardised stackable containers. These can be with or without lids for handling small parts and larger components between manufacturing areas, in-house or externally. The same is true for pallets made of sturdy PP to achieve the best quality, with high stability and high load capacity. In-house, UV-LED inkjet printing solutions can replace the applied labels for maximal flexibility.

STORAGE

Production logistics-system solutions provide help with warehouse storage. So far, the focus has been on the use of applied labels to boxes. These identify the packed goods in each box, with the disadvantage of multiple labels needing to be applied.

In many cases, companies do not have label-printing solutions in-house. They do not consider the flexibility or cost saving and time to market offered by in-house printing. For this reason, pre-printed labels are often purchased from external suppliers and require organisation of a tremendous amount of different pre-printed labels.

Digital-print decoration in the plastic-moulding industry is still seen as a parallel world, which disturbs the material flow in manufacturing processes. Many companies are not aware of the capabilities of inline, single-pass inkjet printing. Speed of line and high resolution can be achieved directly onto flat and slightly curved surfaces, including larger gaps of up to 24mm.

PRINTING PARAMETERS

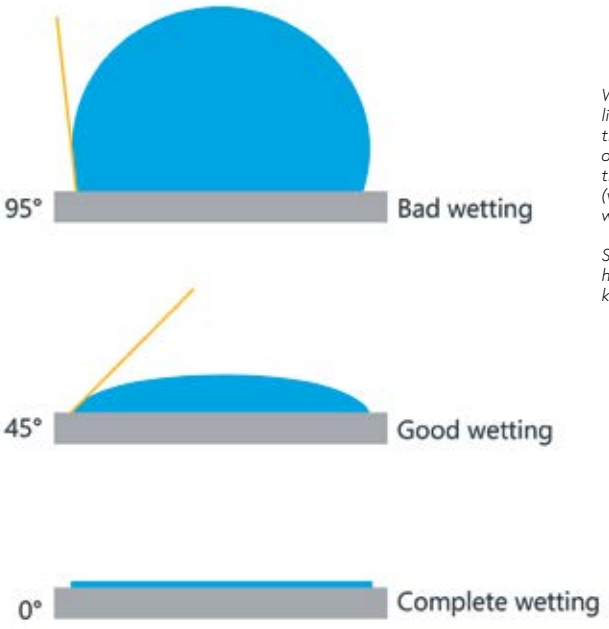
Containers are washed 20 times in industrial washing machines – usually at 60°C for 20 minutes – using standard industrial detergents. Moreover, mechanical resistance of printed barcodes must be sufficient, since these could be damaged by a forklift within the automated-warehousing system.

After 20 washes, PP boxes are recycled together. Coloured in black, they are moulded into 'refurbished/recycled boxes'.

Barcode quality levels must be Grade A, or rating >value 3, 6. Barcodes are printed at the border of the rips, at the right and left bottom corners. A barcode is then positioned directly in front of the barcode scanners in the automated-handling system.

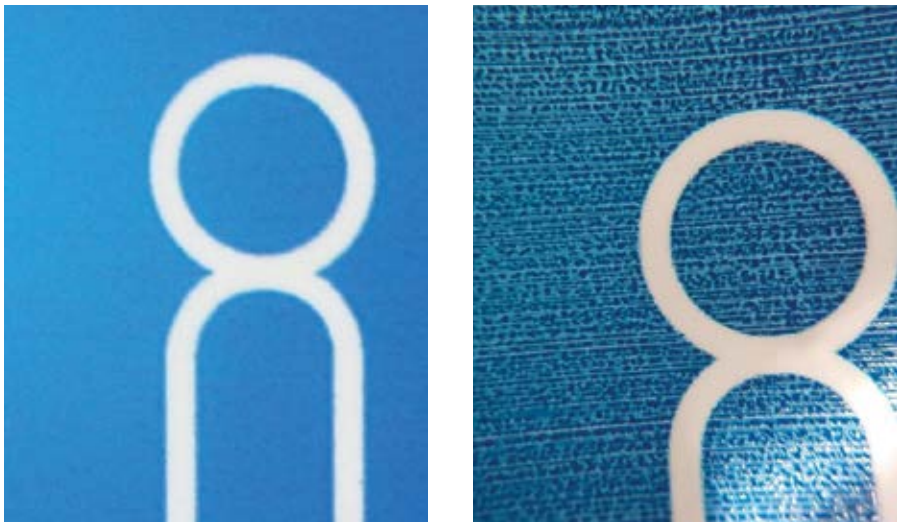
"With inkjet printing it has become possible to print directly onto rigid plastic packaging"

The maximum height of print is 90mm and needs to be able to cover the entire width of the box. It is also necessary to allow for printing of multiple images,



When an interface exists between a liquid and a solid, the angle between the surface of the liquid and the outline of the contact surface is described as the contact angle ϑ. The contact angle (wetting angle) is a measure of the wettability of a solid by a liquid

Source: Kruss GmbH https://www.kruss-scientific.com/en/know-how/glossary/contact-angle



Print quality – good vs poor wetting on substrate. (Image courtesy of Industrial inkjet Ltd)

barcodes or text information in the same line. In addition, space needs to be allowed for multiple barcodes to be printed.

DISTANCE, SIZE, ROUTE AND ADHESION

Print distance is one of the challenges in printing barcodes directly onto logistic crates. These crates vary in size and height, but all have the same major issue – the printable area is recessed in the back, about 17–24mm from the crate's outer border.

It is therefore important to select printhead supplier/printhead technology, which is capable of jetting droplets over 17–24mm, such as with the Seiko RC1536 and the Konica Minolta KM800. Large drops need to be generated to achieve stable droplet flight. However, large drops are achieved with multiple smaller drops and this reduces print speed. Large drops do not give high-print resolution, with a minimum of 360 dpi. Ideally

"In many cases, companies do not have label-printing solutions in-house"

this should be 720 dpi. The aim is to create a stable flight by droplet, from nozzle to substrate, without interference by the pre-treatment flame unit. This flame tends to blow away a lot of air and pushes the droplets out of their flight route.

In pre-treatment/substrate, the general surface tension of PP plastics is around 30mN/m and the ink, 24–26mN/m. Pre-treatment by flame raises the surface tension up to 46–50mN/m and this usually remains for multiple days.

A curve of surface-tension development is determined based on multiple parameters, such as air/gas mixture, flow rate of the gas and temperature at the end of the flame. Additionally, distance and speed with which the substrate passes under the flame plays a major role. From this curve, the ideal setting for the substrate is determined. This gives enough gap for better wetting/flow and adhesion of the ink.

Measurement of surface tension is achieved by measurement pens or liquids. Although, with these, it is not possible to determine the real polarity of the surface.

TESTING

This is now possible by newer measuring technologies, such as KRUSS, which dispenses two drops of polar and disperse liquids onto the substrate. In this way, the surface tension and polarity range of the substrate can be more accurately measured.

Tesa and cross-edge testing are utilised to measure adhesion. Results of GT=0, where no ink comes off the PP plastics box, is essential. After 20 washing cycles, the tesa and cross-edge test is repeated and the same result of GT=0 is expected. Since some of the boxes might be stored outside, a life outdoor storage test is executed for 3–4 weeks. GT=0 is aimed again.

PINNING

Pinning is a process whereby an ink coating is partially cured with low intensity to prevent further dot gain. Imagine the consistency of half-set jelly.

Often it is necessary to print white under the black because the crates are coloured. Therefore, finding the correct pinning settings is a process of testing, combined with experience of interactions between curing and ink properties.

Distance between the printing and curing position is crucial for droplet-spreading time on PP plastics. There is a sweet spot to be found where the time of pinning is not too long or too short. Otherwise, fine barcode lines will reduce in quality the required grading will not be met.

In the wetting/flow of black ink on top of the white, pinning levels and timing between colours is crucial. In addition, the alternating timing of the flame treatment and jetting printhead is needed. Distance between the pre-treatment and print units is crucial for optimal surface wetting and print quality.

INK

Optimisation of the ink formulation will aid in adhesion to PP materials.

In tests, the first ink version was a clear primer, used to adhere to the substrate. The next was the CMYK ink. The final version was the reformulation of white ink, for best adhesion. In a following step, over printability of white with black ink and intermediate pin and final cure were trialed.

CURING

Distance to substrate intensity decreases the further the substrate is from the curing unit. Thus, it needs to be calculated and allowed for in the LED-curing system. It is important to have hybrid-curing capabilities with the options of using UV mercury and UV LED in application. This will result in finding the perfect curing formula. LED curing can be used for pinning before full through cure with UV mercury.

CONCLUSION

Only by thorough and elaborate validation of all print-process components can quality parameters be influenced, including optimal print results. This means ideal settings for the flame treatment, white under-print, pinning, black barcode printing and curing need to be determined for the desired process speed.

By the close co-operation between LED- and UV-systems manufacturers on process parameters, ink manufacturers on ink-formulation design and print-system integrators, an ideal configuration can be achieved for this complicated printing application.

But it is important to realise that inkjet is a robust and mature technology that can be implemented in many manufacturing processes. Key to this is partnership and exchange of information between suppliers.

New application areas are now being addressed, from the logistics of stackable containers, to palettes and large-size containers. ■

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