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The reality of low migration production

White paper

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“Low migration” as a term has been prevalent in the printing ink market and food packaging sector for a number of years. It is a term that is intrinsically linked to food packaging compliance and the production of indirect food contact packaging, where the foreseeable use of the printed package does not result in direct contact between the foodstuff and the print.

As the label and package printing industry has found itself exposed to more types of food packaging and different end uses, so it has come under increased scrutiny from brand owners aware of the risks to their reputation from the fallout from migration. New regulations are being introduced and existing ones updated to ensure the health and wellbeing of consumers is not put at risk from migration.

The digital printing industry has also found itself under greater scrutiny given the growing prominence of the technology as a tool for producing food packaging. With the potential to achieve scale, image quality and low running costs that match, and in many cases exceed conventional printing technologies, inkjet printing has been identified as offering the greatest opportunity to expand the digital printing spectrum. It is therefore of no surprise that the next generation of inkjet presses have been developed with low migration compliance in mind.

‘The perception of inkjet as a viable technology for low migration printing is a work in progress.’

Sharing his opinion, Bill Hine, managing director at UK printer Hine Labels, a user of Screen inkjet technology, notes, ‘There are many differing looks to inkjet print, with some equipment laying down a very heavy coat weight of ink giving a look similar to screen printing. Screen inkjet presses achieve something very near to traditional print methods in appearance. This means different end users have differing views on inkjet technology overall, depending on what they have been presented with. This is directly related to the press and technology used.’

Mr Hine continues, ‘The perception of inkjet as a viable technology for low migration printing is a work in progress. I believe many end users were not aware that traditional inkjet technology is/was not low migration. This will have hampered the perception of inkjet.’

Migration and what to do

In simple terms, ink migration is the transfer of unwanted substances from the printed surface to the product. While low migration has no direct legal definition, such technologies are designed to minimise this and keep migration levels below acknowledged limits.

There are four primary ways in which migration can be driven by the interaction between food packaging, its surroundings and the food contents: diffusion, set-off, vapour phase and condensation extraction migration. These each bring their own challenges. Diffusion migration, for example, is a risk when the incorrect selection of consumables and/or improper curing allow migration through the substrate. Set-off migration occurs when the printed surface comes into contact with the reverse, either when rewound onto a reel or stacked.

Further, food packaging application safety is determined by the substrate type and thickness, ink laydown and print coverage, end use conditions and the foodstuff itself.

As such, it is necessary to consider each step of the process to achieve food packaging compliant production. From the press configuration to the substrate being run, then curing and onward processing, each has to be factored in. Even before printing, the design of the packaging must be fully considered to ensure it is able to be produced according to low migration characteristics. Does the design require a heavy laydown of black/white ink? What is the total print area?

On-press, converters working in food packaging are advised to install extra controls to ensure that non-visible set-off does not occur and that the printing inks or varnishes used are drying or curing to their full degree. For water-based and solvent-based inks, this includes ensuring that the levels of residual solvents and other volatile substances are at the lowest level possible. For UV curable products, regular maintenance and calibration of the lamps is advised to ensure the correct UV dose is reaching and penetrating the substrate surface to sufficiently cure inks and varnishes. Specific systems are available with more in development to monitor and evaluate this important element of the UV printing process.

‘Low migration ink is just one component of a fully integrated supply chain for ‘food safe’ packaging’

The Screen Truepress Jet L350UV+LM UV inkjet press comes equipped with a nitrogen purge mechanism that dramatically reduces extractable ink components after printing. This directly relates to mitigating the risks from diffusion migration, as when oxygen is present it interferes with the curing process and makes it impossible for inks to fully polymerise. The sensors in the nitrogen chamber of the Truepress Jet L350UV+LM dictate that the press will not run if oxygen is present. This guarantees that low migration printing is actually delivered

at all times. Optional chill rollers then expand the versatility and flexibility of material types that can be supported to include thin and heat-sensitive films. Together they help to extend the benefits of digital technologies for variable and short-run printing to a larger range of food packaging applications.

However, it is in the inks that real innovation has been necessary to ensure low migration and food packaging compliance when printing with UV inkjet.

The individual components will impact the final composition, with different digital ink types featuring different molecular structures. While dry toner inks are known to contain larger molecules, making them less likely to migrate, the initiators and monomers included in UV inks are extremely small on a molecular level and have the potential to penetrate general food packaging and enter the food inside. The low viscosity of UV inkjet inks is also known to make it hard to achieve a proper cure once they penetrate the substrate.

Screen's proprietary low migration inks are specially developed with a unique material composition to work with the nitrogen purge mechanism to accelerate and deepen UV curing. Together, they are highly successful in reducing the migration of ink components. This has been proven through third-party tests, with a certificate to show their suitability as part of a low migration workflow available from the testing laboratory Triskelion (a TNO initiative) in The Netherlands. The odours inherent in UV inks are also minimised by maximising the ink curing ratio. This ensures the printing process has no impact on the flavour of packaged foods.

Screen's low migration inks can be used in certain applications without risk of migration. Based on third party migration test results, this applies if there is a PET layer of more than 25 micron between the ink and the food, or a 40 micron PP barrier in the case of non-fatty dry food. This is in addition to those applications involving glass and aluminium containers, which are known as functional barriers.

Functional barriers prevent the migration of substances present behind the barrier towards the food. This is achieved by their molecular structure preventing the diffusion of migrants, in use and during processing at higher temperatures. If a substance is not part of the food-contact surface of a package and is separated from the food by a barrier that prevents migration of the substance to food, then the substance is not reasonably expected to become a component of food. A functional barrier can be determined by considering the package structure and the exposure conditions anticipated for the package based on the intended conditions of use, and moreover through diffusion modelling or migration testing by independent third-party testing laboratories.

The following factors affect the migration of chemicals from food contact materials into food:

- Temperature, with chemical migration increasing at higher temperatures;
- Contact time, as migration levels increase with time;
- Surface-to-volume-ratio, with small packaging sizes having high ratios leading to higher migration levels;

- The type of food, with many chemicals more readily migrating into fatty or acidic foods;
- The nature of the food contact material and its composition, whether plastics, paper, glass, metal, etc;
- The type of contact, such as direct or indirect, whether a solid or liquid foodstuff, and the presence of a functional barrier;
- Physico-chemical properties of the migrating substance, such as volatility/vapor pressure, water solubility, octanol solubility, polarity;
- Mobility of chemicals in the food contact material, depending on if they are impermeable, permeable or porous; and

Kinetics and thermodynamics directly related to the migration process, affecting how fast and to what extent a substance will transfer from the food contact material into food.

'It is beneficial if the testing laboratory has a close relationship with the manufacturers involved'

As such, it is necessary for the testing laboratory to establish the correct parameters within which migration testing is conducted and to ensure compliance and food safety. Examples include: organoleptic testing, for taste and odour; practical migration tests on the printed packaging material, both empty and full; and calculation of possible worse case scenarios. These tests can take place over a number of days at elevated temperatures to simulate real-world conditions. Tests involving pressure are also carried out to simulate storage conditions of print products.

In the case of inks, it is beneficial if the testing laboratory has a close relationship with the manufacturers involved so that they have access to the formulations and can accurately analyse any potential migration species. Screen has established links with test laboratories, such as Triskelion and Swiss Quality Testing Services (SQTS), regarding its LM ink portfolio. A customer can seek advice from such independent migration testing laboratories based on this information.

Legislation

The aforementioned all feeds into the ever-more complex regulatory landscape that printers and converters must work within.

This includes legislation put in place in Europe, North America and Asia. EuPIA (the European Printing Ink Association) has a number of regulations in place related to food packaging, such as its enhanced Good Manufacturing Practices (GMP) guidelines that cover

the manufacture of all varnishes and coatings as well as inks designed to be printed on to food contact materials, including all non-food contact and food contact surfaces of packaging and containers. Inks, coatings and varnishes developed and manufactured in compliance with this GMP support manufacturers of food contact materials in supplying products that are fully compliant to all applicable European legislation for materials and articles intended to come in to contact with food.

Permissible migration is already very low, with less than 10 parts per billion (ppb) widely regarded as having no effect and >50ppb requiring full evaluation and approval by a competent expert. Regardless, any maximum migration limit is dependent on the toxicological profile of the migrant in question, which must be identified and assessed. Even at <10ppb, there must be no material detectable with potential carcinogenic activity.

'Responsibility for ensuring safety and food sensory integrity of the printed package lies with the printer and the client'

The term "low migration ink" is actually no longer used by EuPIA, reflecting advances in this area. Instead, EuPIA uses the term "printing inks for food contact materials" for those printing inks which are designed to be applied on a material that is in contact with food. These inks are required to be compliant with the EuPIA GMP. Individual EuPIA members may still use terms such as "low migration ink", "ink optimised for migration", or others. In these cases, converters are invited to satisfy themselves that these inks fulfil the requirements of the EuPIA GMP.

Within the US, FDA regulates the materials that can be used in items (packaging) that will come into contact with food. There is a basic assumption that any materials used in food contact applications will become part of the food unless documented testing proves otherwise. The FDA provides a list of approved materials in CFR Title 21. Inks and coatings that do not have direct food contact are not regulated. This comes into effect as long as there is a functional barrier between the food contact side and the ink or coating, and the inks and coatings do not migrate to the food contact side during various steps in the process. It is the responsibility of the packaging manufacturer to determine if the construction meets the definition of a functional barrier.

Moreover, many of these pieces of legislation do not relate directly to the ink, rather the constituent raw materials that can migrate to the food. In the case of FDA, these must be approved as a food additive. Legislation in Switzerland (SR 817.023.21) demands that all ink raw materials for food packaging have to be listed and comply with specific migration limits (SMLs). Japan's Food Sanitation Law sets out that contamination of foodstuffs by their packaging must be avoided, while GB 9685-2016 in China sets out a positive list of additives that can be used to produce various food contact materials and articles including their use scope and restrictions.

Nestlé Guidance Notes are widely revered as industry performance benchmarks in this area. Its Packaging Inks note specifically addresses inks used for outside of Nestlé packaging materials. While requiring local legislation, where applicable, to be followed, Nestlé goes on to outline an extensive list of pigments, photoinitiators, acrylates and solvents that should be excluded.

Low migration inks for Truepress Jet L350UV+LM systems comply with a number of regulations related to food packaging, including: Article 3 of EU 1935/2004; EU 2023/2006; EuPIA Exclusion Policy for Printing Inks & Related Products (December 2018); EuPIA Suitability List of Photo-Initiators for Low Migration UV Printing Inks and Varnishes (February 2013); EuPIA Good Manufacturing Practice (GMP), Printing Inks for Food Contact Materials (March 2016); Swiss Ordinance SR 817.023.021 Annex 10; and the Nestlé Guidance Note on Packaging Inks (October 2018).

Conclusion

It is important to remember that low migration ink is just one component of a fully integrated supply chain for 'food safe' packaging – a final 'food safe' solution is a result of design, materials, construction, process and product.

In all instances, it is critical to note that migration levels are subject to individual migration tests. All materials in the package structure are evaluated for low migration, including the ink, substrate and adhesive. Migration tests on the complete packaging construction are recommended as they may vary depending on the conditions of use. Also, the nature of the product to be packed has a direct impact on migration, with fatty foods more prone to migration then dry foods.

Neither is it possible for low migration inks to be used with, or substituted for, standard inks. Rather, detailed analysis must take place to ensure the entire production cycle is suitable to achieve the rigorous demands of low migration and be deemed food packaging compliant.

Moreover, the responsibility for ensuring the safety and food sensory integrity of the printed package lies with the printer and the printer's clients.

By working closely with companies such as Screen that are developing products specifically with low migration characteristics in mind, it is possible to demystify the production challenges. Screen products are already used by converters in food-safe production. Hine Labels is one of those, as Bill Hine states: 'Customers expect us to supply products that meet the requirements for the intended end use, printed with good quality whilst being safe!'

With Screen's low migration products, converters have access to the tools they need to enter new markets and take on a broader range of label and packaging jobs in the knowledge that they are best placed to achieve food packaging compliant production.

This white paper has been prepared on behalf of Screen Europe by Bridger Howes Limited.

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