The Correct Selection of Inks and Coatings in Package Printing

By Anthony Bean

Although concerns about the correct use of packaging materials (film, foil, board and plastic) to protect various food products have driven packaging design, the selection of inks and coatings to decorate that package has received less attention. Obviously, the ink/coating products were chosen for very good reasons. Graphics on the package need to have the correct color, shade, hue, fade resistance, chemical and product resistance, as well as a variety of other attributes to fit the end-product needs. Similarly, coating technology has evolved to enhance the performance of the package, giving superior gloss, scuff, slip characteristics and other important processing attributes.

Due to the newer nature of ultraviolet (UV) and electron beam (EB) products, these materials have come under higher scrutiny and often are required to have higher performance qualities. One area where UV/EB technology has been questioned is food packaging and concerns about odor and off-taste. Concerns about conventional technologies are certainly no less, but because these technologies have grown up with packaging needs, their issues were dealt with and resolved as the systems matured. For example, the impact of a slow-boiling solvent contaminant in a solvent-based ink was identified and the material was removed. The issue of an amine-coalescing agent in a water-based product was discovered and the material was removed. Many of these growing pains took place as the technologies grew and became refined. They were considered part of the learning process. Although there were stumbles along the way, it is hard to remember any of the significant media-covered recalls that have taken place in recent years.

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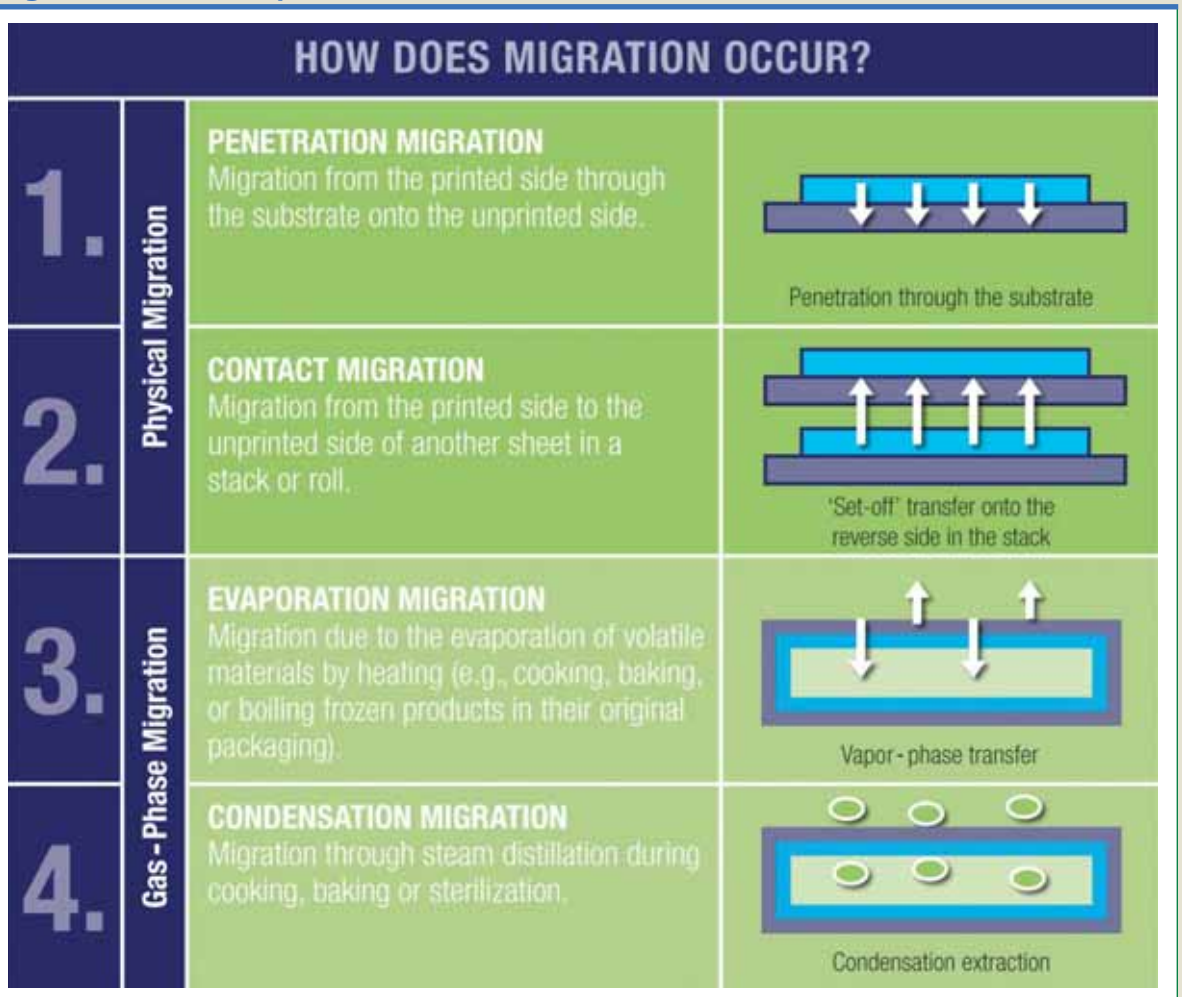
The end result of all this is that with the recent increase in the number of food packaging migration alerts—highlighted with several high-profile product withdrawals from supermarket shelves—regulatory agencies are beginning to draw up guidelines for proper manufacturing of packaging used for food and pharmaceuticals. This action will actually benefit UV and EB technology since it will provide an even playing field with defined needs that, in many cases, UV/EB technology already strives to meet.

Much of this activity is taking place in Europe, but the impact will be far reaching as brand owners adopt guidelines and insist upon them for their products around the world. Already, there are several major companies leading the way with various lists of acceptable and unacceptable materials. The developing guidelines will not be exactly the same as FDA regulations, but will parallel them. The purpose of this paper is not to explain the similarities or differences, but to present a framework for proper selection of packaging materials.

For years we have recognized that packaging materials cannot impact the food product that is packaged. The discussion has been around low odor, low taint or off-taste. Although these performance characteristics are very valid and will remain a keystone for good packaging, the definitions of these parameters are not as easily tested. Putting the food item in with the packaging material under controlled time and temperature and then tasting or smelling the food product is the norm. Although this is a good real-world test, it is time consuming and requires experts to gauge the impact of the tested item on the food product.

TABLE 1

Migration into food products



Some items are more sensitive to odors and off-taste, just as some people (expert tasters) are more sensitive to the food product alteration. The change in flavor, smell or other attribute is caused by the migration of various materials into the food product (See Table 1). It is certainly possible that migration of various items from the package to the packaged goods may not always be detected by organoleptic testing or when consumed, but may be detectable with various sophisticated analytic equipment.

Many printers mistakenly assume that if the product is not in contact with the offending material, the food product is safe. This is not true, as there are several ways migration can occur. Other than direct transfer, materials can also migrate by penetration, backside transfer or through a gas phase during storage or preparation.

While this paper focuses on inks and coatings, there are many more potential sources of contamination that must be considered and possibly eliminated, depending on the impact on the packaged food product (See Table 2). Starting with the substrate (though it has been selected for end-use), it can be altered during processing. Certainly there is the potential for the UV or EB energy to interact with the substrate or a component of the substrate and cause issues. It is known that UV and EB energy can crosslink Polyvinylidene chloride coatings and raise the sealing temperature. Polyvinyl chloride shrink film can change color. There are incidents of the board or paper emitting a bad odor after UV/EB exposure due to interaction of the UV/EB energy with the styrene butadiene latex. The inhibitors in polyethylene have been known to interact with UV energy to create odiferous by-products in the early days of UV curing, but that has since been resolved. All of these possible sources must be considered if the use has not already been proven acceptable.

Recently, there has been concern about mineral oil. One source of the material is in printing ink. Various hydrocarbon oils are used in a variety of lithographic and letterpress inks. Although these inks are not commonly used for food packaging, the paper products printed for newspapers, magazines and various brochures (among other end-uses) often find their way into the feed stream for recycling and end up as a component of recycled paperboard. Not all recycled paper has this issue, but it is a potential source of migratory species.

Certainly the inks, coatings and adhesives can be a source of various contaminants other than mineral oil. In energy-curing products, the curing mechanism is never 100% complete, so material such as the monomers can be available to migrate. This can be minimized with the correct choice of monomers, but it is always a potential issue. In UV curing, the photoinitiators are an obvious source and this has led to the elimination of several materials that (while good for photopolymerization) are bad for migratory action. Newer polymeric materials minimize the chance for issues, but must still be carefully chosen.

The printing press can be an unsuspecting source of migratory items and can be overlooked by the uninitiated. For flexographic and gravure printing, the cleanup of a print unit is fairly straightforward, but care must be given to the corners of the sumps, hoses, pumps and any other area where unwanted chemicals can reside and come out into the low-migration product. On lithographic presses, the roller train is made up of some type of rubber rollers. Rubber

TABLE 2

Possible sources of migratable materials

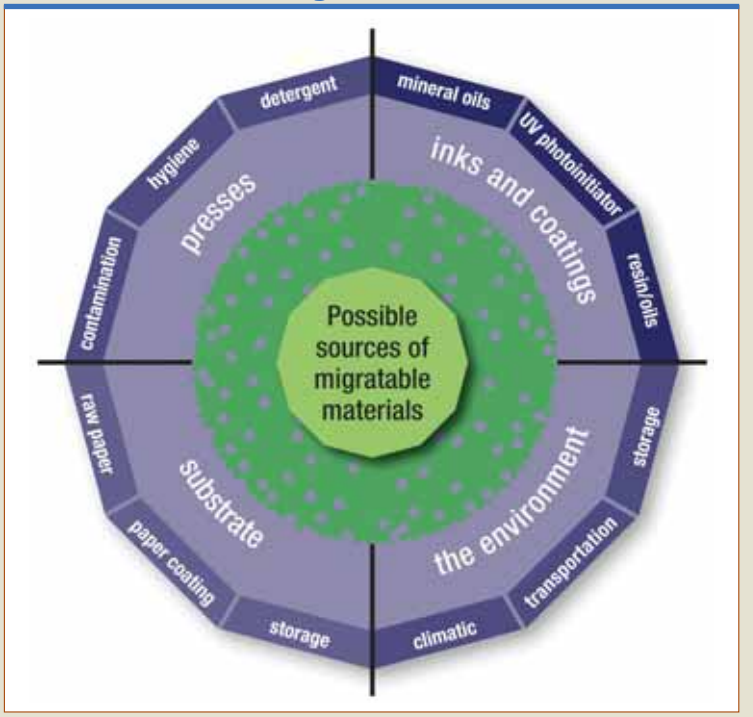


FIGURE 1

Migration problem in Europe

Germany withdraws noodles after benzophenone leaches from packaging

By Rory Harrington, 19-Apr-2011 Post a comment

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Hundreds of boxes of noodles have been withdrawn from sale in Germany after levels of benzophenone almost three times above the European legal limit were found to have migrated from the packaging.

is a porous material that can account for material leaching out long after cleanup has been completed. Fountain solutions, plate cleaners, roller washes and other chemicals used in the pressroom can find their way into the end product and create problems unless they are carefully controlled.

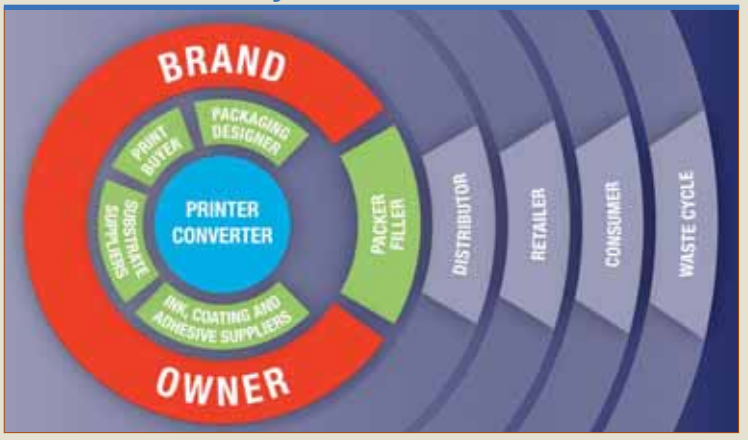
Even after the proper substrate, ink/coating and press conditions have been met, it is possible for the end product to be contaminated during storage or transportation. Depending on the sensitivity of the product, this adds another layer of complexity that must be considered to meet the highest levels of acceptability.

In the U.S., the Food and Drug Administration (FDA) has regulations regarding various components of food packaging. A key element of this is that the industry is self-regulating as long as there are not any issues. This means that the FDA does not typically police all packaging and expects the various users to make sure that the packaging is within the Code of Federal Regulations guidelines. The FDA guidelines categorize inks and coatings as direct contact (expected to be in contact with the food product), indirect contact (expected to come into contact with the food product in normal use) and incidental contact (NOT expected to come into contact with the food product in normal use). Most printed packaging is used under the "incidental contact" definition and/or where there is a barrier. For much of the industry, the assumption is made that the substrate is a barrier, and this has been assumed to be correct due to the lack of issues that have arisen over the years. The reality is that very few people check to make sure that this is true. Even with a substrate that is an effective barrier, there can still be transfer of materials to the backside during manufacturing where printed products are rewound or stacked.

There have been various instances where ink, coating or adhesive components have migrated to the food product. Although there have not been any issues that resulted in true health concerns, the discovered items have resulted in costly recalls, loss of consumer confidence and proposed regulations to prevent future occurrences. These occurrences have not been in what many regard as poorer nations and a recent issue in Germany (Figure 1) with UV inks is surprising due to the known issues. Although the supplier of the materials may or may not have known of the issues, there are many items printed where the inks/coating/adhesive supplier does not know where their products are being used. There is a tendency in the U.S. for commercial printers to try to pick up extra business to fill their presses, and such work may be picked up from the packaging market. The typical commercial printer may not have the familiarity with the concerns of food packaging, and may use a product that is satisfactory for commercial work but not for odor- or taste-sensitive items that also have to meet various regulatory demands.

FIGURE 2

Communication Layers



The issues can certainly be avoided by better communication between the various parties involved with the design and manufacturing of any package. There are some industries that are very much involved with this and specify materials to be used all the way through the process (Figure 2). They may also have guidelines established that assist the printer/converter, ink/coating/adhesive supplier and package designer in selecting the correct materials to ensure that the finished product meets their needs. It is really the brand owners of the items who need to act as the overlords to make sure the manufacturing and distribution of their products do not result in issues.

The choices available for food packaging have certainly expanded over the years, and the options have provided many new opportunities for smart brand owners and marketers. At one time, the concern was to protect the packaged material from damage, assist in storage and display, and provide some basic information. Today, packaging must provide shelf appeal; significantly enhanced communication; be recyclable and sustainable; extend the shelf life and support modified atmosphere packaging; be lightweight; provide a cooking vessel; and, in many cases, possibly even self-heat. All of these attributes must also be provided at a reasonable cost against alternatives in an ever tougher market. At the same time, the regulatory landscape is making it safer but more difficult for the package to comply with all the demands that are being placed upon it.

For the package to deliver all the required attributes, planning must include the full life cycle, including the types of inks and coatings to be used. Although the packaging design will usually specify packaging materials, seldom are the types of inks, coatings and adhesives part of the specification. This does not necessarily mean that the designer would single out UV or EB products, but that is the case in some instances where properties such as high gloss or particular resistance properties are required. Usually that choice is left up to the printer/converter, but if the packaging needs that have been discussed are not part of the job specification, the final choice may be incorrect for the end-use.

FIGURE 3

Food packaging in the past

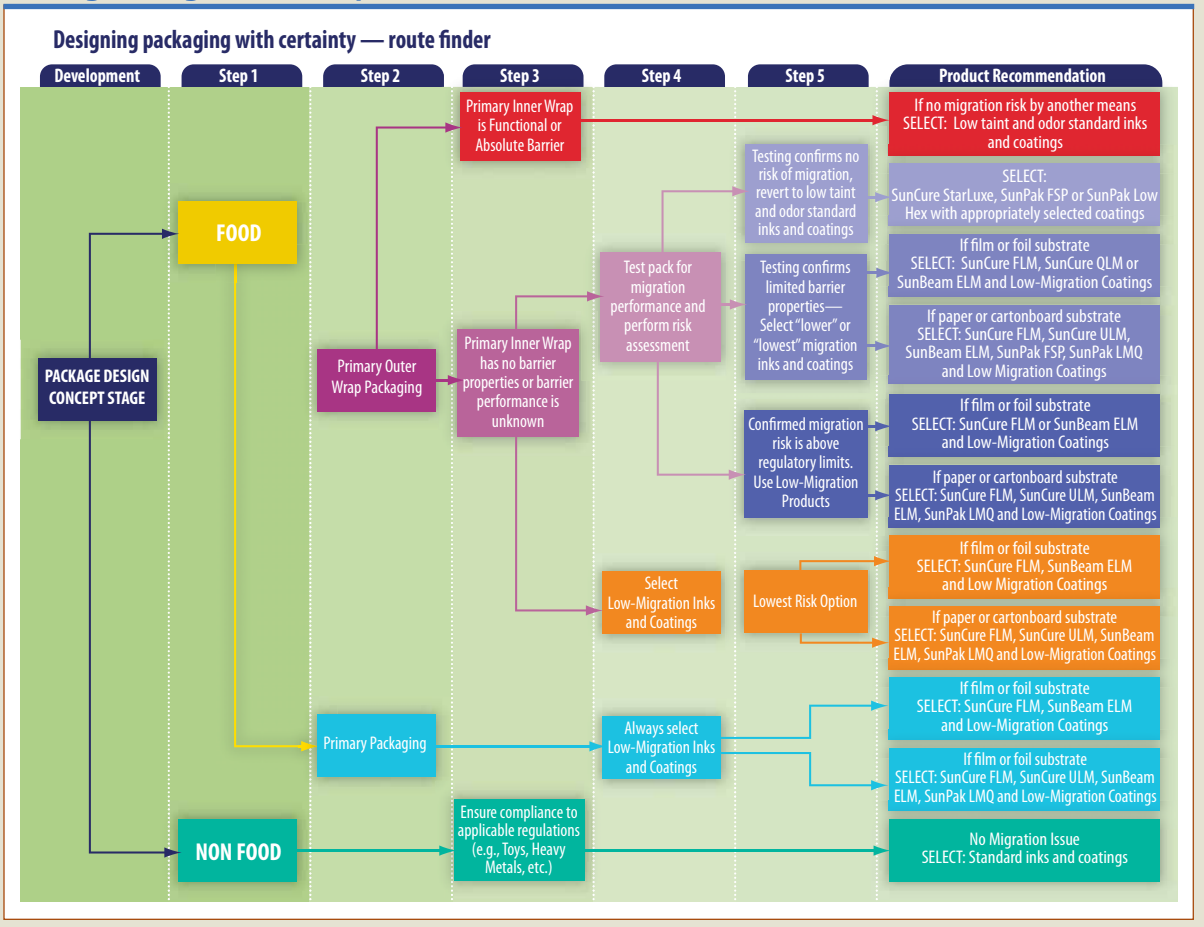
At this time, the options appear to be coalescing into some rough guidelines in Europe that are compatible with U.S. FDA guidelines. Although odor and off-taste impact on a food product can vary significantly, the general approach is that if the package and packaging materials impact the product with a contamination of less than 10 parts per billion (ppb), the level is "acceptable" as long as it is not a toxin. Certainly, if the material noticeably alters the food, it is not fit for use even at these low levels. To achieve this level, it is necessary to utilize materials that are low-migration. There is a level from 10 ppb to 50 ppb where the concern about the migratory item is acceptable if proper toxicology data exists to support that conclusion. Again, the material must be fit for use and not alter the food product.

Over the 50 ppb migratory level, a full toxicological evaluation would have to exist or be performed to validate use as appropriate. In the U.S., this would require petitioning the FDA relative to the particular use. Again, this applies to any ink, coating or adhesive used in packaging and is not specific to any chemistry type or printing process.

The easiest way to look at this is as a decision tree during the package design. The first question would be "is this for a food or a non-food application?" If it is a non-food or non-sensitive application, any ink/coating/adhesive that meets the performance requirements should be acceptable. If it is for food or a sensitive application, the question would be "is this a primary or outer wrap?" Primary packaging typically requires low-migration products to ensure there will not be an issue. If it is outer wrap and there is an effective barrier (for the chemistry in question), then standard materials can be used. If there is not a barrier, then low-migration inks are recommended to provide the lowest possible risk. Inks that are not low-migration can be used, but it is highly recommended that proper testing be

TABLE 3

Package design decision process



implemented to ensure that the use does not compromise the package. This process can be visualized with the help of Table 3.

The responsibility of making sure that the packaging is correct for the end-use starts with the brand owner and their design team. Communication of needs must be properly passed on to the printer/converter and they need to relay this information to the package's component suppliers—ink, coating and adhesives. The suppliers of these individual components must make certain that the formulation is fit for use when applied properly by the printer/converter. Since UV and EB items form new polymers during curing, it is also up to the converter to make certain that these items are properly applied and cured so that the materials meet the end-use expectations. Every supplier of UV/EB materials can assist the printer in setting up the correct testing protocol for the application needs, but the responsibility rests with the printer/converter.

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