# *Analysis of Peelable Film in Food Packaging*

**2008-09 Italian Packaging Technology Awards Program**

Matt Baker

Department of Packaging Science
Clemson University

February 11, 2009

## Abstract

This paper is an analysis of peelable lidding films used in cup and tray style food packaging applications, focusing on what should be considered when developing a new package or adapting an existing package application to a peelable film. Three types of peelable films will be discussed and how they influence the various parts of a packaging line and also any advantages and disadvantages at each point in the packaging line. This paper will also focus on the machinery aspect including both hot fill and retort applications. However, to do so, requires an understanding of the film and what affects a packaging machinery change may have on transportation and food quality, therefore several post production areas will also be mentioned. Medical bags or pouches such as those from vertical form fill seal machines are not under the same production conditions as cups or trays so they will only be mentioned when and if applicable.

## Introduction

The key focus on any peelable film is to increase the ease of use for the consumer without compromising any of the other properties of the package. Traditionally, film covered trays or bowls are welded together either by heat or ultrasonic methods. These extremely robust seals provide superior tamper evidence, but it can be difficult to remove without a cutting utensil. “[Consumers] don't want it to be really difficult to break the seal because you end up tipping the contents all over yourself"(Packaging News).

Peelable films were first used to package medial equipment so that the packages were easy to use in operating rooms and emergency situations. As plastic technology has developed, new applications for peelable films have been applied to the food industry. While the idea of a peelable film is the same, the food industry exposes packaging to different stresses than those found in medical packaging. Subsequently new materials and combinations of polymers have been adapted to meet these requirements.

## Three Types of Peelable Films.

There are three basic ways a film can be designed to peel which is also referred to as the type of failure. These types of failure are adhesive, cohesive, and the less used delamination. All three types are easier to interpret with these diagrams from Rollprint Packaging Products Inc (Dodrill).

**Adhesive:** Adhesive is a type of film failure in which the adhesive pulls away from the container just like a piece of tape.

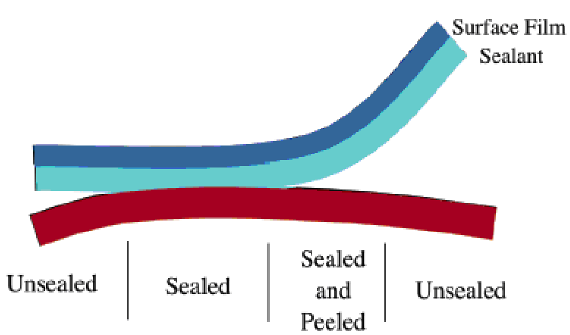



Figure 1. Adhesive Peel

The first advantage of adhesive film is that it leaves no residue behind after being peeled. This leaves the container aesthetically pleasing. The disadvantage is that there is no indication of peel quality. This makes them less appealing for medical products or perishable foods where an indication of contamination is helpful. The residue as a quality indicator will be discussed further in the cohesive film section.

Because of their simplicity adhesive films can be less expensive that other types of film. However, this simplicity can also result in a film that does not perform all functions well. The adhesive layer is performing hot tack, seal and peal functions all within the contact area of the film and the container. Hot tack is the strength of the bond between the film and its package immediately after being sealed (Marotta 613).This multitasking often results in a film that requires more force to peel, or not have enough hot tack strength for hot fill applications.

Lastly, adhesive failure films are more susceptible to welding. Welding occurs when the adhesive layer has been extruded typically as a result of too much time, temp or pressure from the sealing heads.

**Cohesive:** The second failure type is Cohesive, where the adhesive layer is designed to fail inside itself as shown in the “sealed and peeled” section of the diagram from Rollprint Packaging Products (Dodrill).

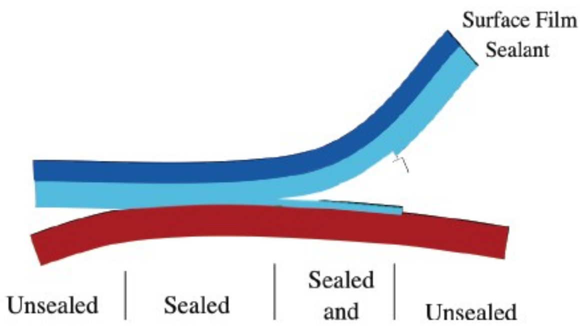



Figure 2. Cohesive Peel

The cohesive failure film is more complex in the design of its adhesive and thus is more expensive to produce. Unlike adhesive failure, it does not perform the seal and peel function at the same point in its structure. This ability to peel “inside itself” means that the film can have higher seal strength than it does peel force necessary to remove it. This means a stronger seal and a more functional package for the consumer.

Cohesive films have the disadvantage of being thicker than adhesive failure films. This is because the adhesive layer must be thick enough to seal and to have room to fail within themselves. An increase in thickness may result in lid fitment issues or sealing issues on the production line.

The main characteristic of a cohesive failure is that it leaves behind a residue of adhesive or “seal transfer” that is noticeable on the container from which it is removed. Customers may find this opaque band around the rim of the container unappealing. There is also a matching ring on the removed film that corresponds to the area where the adhesive was removed. “Seal transfer provides a visual method of evaluating seal integrity” (Petrie). If there are lines in the film or missing sections of residue on the container, it may indicate an improper seal. This ability to observe seal quality is helpful to ensure a sterile and uncontaminated product.

The largest disadvantage compared to adhesive failure films is that if there are irregularities in the film or sealing parameter (time, temp, pressure), the film may “string” or produce “angel hair” as it is removed. Angel hairs are thin pieces of film that remain attached to the container and may fall into food products. Angel hair is the most obvious visual queue of poor performance of a film to consumers and is therefore important to prevent.

**Delamination:** A delamination film is designed to fail between the substrate and the adhesive layer.

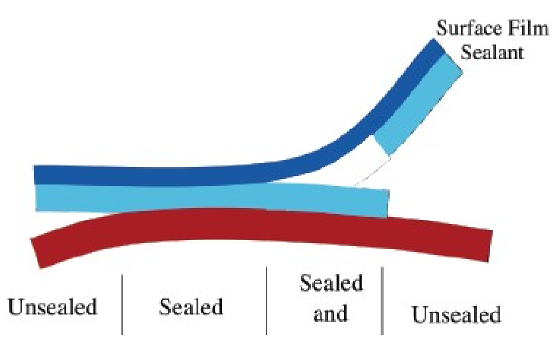



Figure 4. Delamination Peel

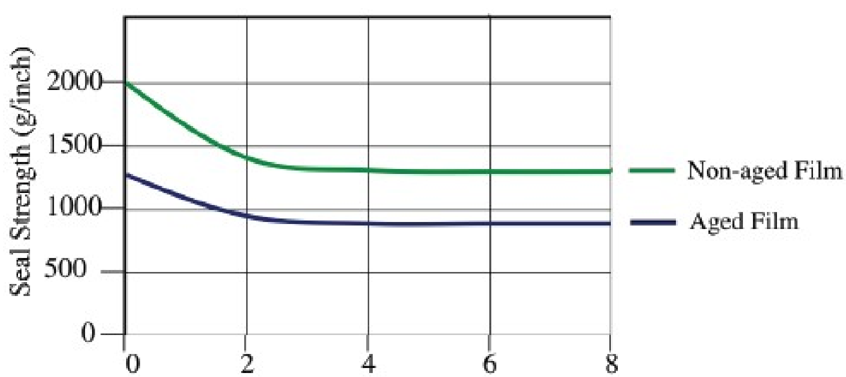
This film is the most likely of the three to produce angel hair and inconsistent peel quality (Dodrill). Delamination is also the least common of the three failure types.

## Machinery Production Considerations

In comparison to welded films, peelable films seal best at lower temperatures and lower pressures but with longer dwell times. While it is difficult to eliminate this problem, the goal is to operate as close to the original line speed without the packaging quality suffering. Since food applications of this sort are either hot filled or retorted, the film will need both a sufficient hot tack and a strong seal. In production, there are many adjustments that can be taken into consideration to help achieve a sufficient seal.

To compensate for peelable films, four things must be considered: sealing parameters, container, film, and the machinery itself. Each can be adjusted in some areas but are restricted in versatility elsewhere. The following will cover each of the four and how they may affect the manufacturing and machinery of a peelable film food package.

**Parameters:** Before making a change to peelable film, it is important that a machine be able to easily adjust its time, temperature and pressure. Even if all three are adjustable they may not have the range necessary to compensate for the new film. This is especially true with the pressure adjustments on older machinery.




As shown in the figure above from Rollprint Packaging (Dodrill), not only is there a difference between an aged film and a non-aged film, but there is also a reduction in seal strength over time. The data illustrates that the production time line will also be a determining factor in the success of a film, and machinery may need to be adjusted accordingly. If a roll of film is stored for an extended amount of time it might not perform to its original standards even if all other parameters are constant. As a result what once may have been considered outside variable become relevant when adjusting a machine to run a peelable film.

**Container:** In tray or cup food packaging, the container has an affect on the machinery and the film performance. One of the best ways to ensure the success of a peelable film is to use a container with a wide rim or lip. The larger sealing surface provides a good contact area for the seal, and the larger surface helps alleviate several other potential issues.

First the larger sealed area exponentially increases hot tack and seal strength without greatly increasing the force necessary to peel the film. The larger area reduces the chance of channels or defects in the seal area as well as helping compensate for any discrepancies in older sealing heads. Finally, the larger area can withstand more pressure from the sealing head without the adhesive layer being extruded out the sealing area. If any adjustments are made to a container, it may not sit in platens as well or jam up a lidding machine, so appropriate adjustments to other line components should be made.

A larger flange or lip does have one drawback: the large flat surface increases the chance of food contamination. Under fast filling conditions or intermittent production lines, food is often sloshed and can end up resting on the container lip. Most food contaminates that are small or liquid are pushed away and have no ill effects. However, food such as green beans or bits of garnish are harder to remove and can remain in the seal. Careful monitoring of production is necessary because even with particulate in the seal, a container may still hold a vacuum for days, but will not be shelf stable.

**Film:** The film is one of the easiest aspects of production to change besides the sealing parameters. If the machinery cannot provide sufficient sealing, another option is the addition of a heat seal coating. “Heat seal–coated (HSC) materials can be formulated to have excellent hot-tack properties, and can therefore form seals under a wide array of sealing conditions” (Petrie). These coating can also allow a variety of polymers not normally considered for heat seal applications to be used (Petrie). More polymer choices may save cost or provide much needed advantages in other areas of the production process.

A film that is too thick, foe example, may cause the lid not to seal properly and jam the lidding machine. In this case, it may be advantageous to thin the film and use a stronger polymer for the substrate. A thinner film will take less dwell time to reach the heat sealing temperature at the heat sealing interface (Miller 143).

Choosing to use a peelable film is inherently more expensive than a welded film. That cost can increase further if a proprietary film needs to be developed or modified. With new peelable technologies in constant development, specific polymers and additives are becoming cheaper. When a company chooses to develop a new package or modify an existing one, a film converter or manufacturer will be able to assist in deciding which film is best for that application. In depth discussion of different polymers is outside the scope of this paper. However it is important to choose the best film to make the total package development as smooth a process as possible.

**Machinery:** When Sealing Trays and cups for food applications, the most important factor is line speed. Line speed directly affects dwell time and is the hardest to adjust as compared to temperature and pressure (Petrie). Traditionally with a heat sealer designed for welding, the temperature and pressure are high, but the dwell time is very short. This is especially apparent in rotary sealing machines. However, with modern computer controlled sealing machines the dwell time can be increased by fractions of a second without slowing the line. Another option of more modern sealers is to have a seal head that can also heat from the underside. This provides a more consistent temperature in a shorter dwell time, which increases the hot tack, in thicker peelable films

Other issues may result if a machine was not originally designed for peelable films. These include seal heads that were not machined to high tolerances, or variations in pressure across a multi-head sealer. The multi-head sealer can be especially frustrating if one bank of sealing heads are not producing a seal but the other seals normally. While these variations were insignificant with welded films, the adhesive layer of a peelable film is much less forgiving.

If a seal head contains both the heat sealer and cutter, the proper pressure for the film may not be substantial enough to provide a clean cut. As a result, the winding roll will peel the container. In extreme cases, the entire package may be pulled from the platen, throwing product and calling stop to production.

The filler and sealer are not the only production elements that may need to be taken into consideration in applications of peelable films. One example would be steam or vaporized hydrogen peroxide (VPH) sterilization in aseptic food packaging. These processes would need to be tested to determine the effects on seal strength for each application.

Down line from the filler, any rough transitions or handling may cause a peelable film to fail. In the case of hot fill products, after they are removed from the chiller the film will have recessed into the container. This is due to the change in the internal pressure. If the film is not recessed into the package, then the seal has not held its vacuum and should be deemed contaminated. The drastic change in temperature and the often slippery and wet conditions of a chiller can cause leaks that are not easily recognized. A post chiller check of seal integrity is important, because water form the chillers can be drawn into small seal leaks. If a retort is used, excessive condensation in the package may be a sign of seal failure and contamination.

As previously mentioned, rough transitions may damage a container down the line. Bumping of containers as they slide into an accumulator could pose a potential issue. Short drops onto an accumulator during hand case packing, could not only break a seal but stop the run for clean up.

When sealing peelable film, there are many machinery issues to consider as well as a matrix of other factors. With the many variations of film, machinery, and production considerations, all issues addressed here by no means should be considered all the ones possible. Test runs with helpful capable suppliers and staff will efficiently address all problems that may arise when starting a new peelable film line.

## Testing

Testing of peelable films throughout the development process is essential. Proper testing will provide quantitative data on film and packaging machinery performance. And can also provide qualitative data that may foreshadow consumer opinions. Testing can be separated into categories where each group addresses related issues. For the purpose of this paper the tests are separated into three main categories: performance, quality assurance, and end use. These categories have been assigned to demonstrate how each group will help pinpoint any issues one the manufacturing line. All of these tests should follow the basic ASTM (American Society for Testing and Materials) or ISTA (International Safe Transit Association) guidelines where applicable, to give a consistent picture of the packages performance.

**Performance group:** Performance test provide quantitative data. This data is used to ensure consistent manufacturing and to resistance to damage from handling or distribution, so that a product safely reaches the point of sale. Basic tests would include, seal strength/integrity (ASTM F88, F1886, F1929, F2228), hot tack (ASTM F1921), drop testing (ASTM D5276), burst strength (ASTM F1140, F2096, F2338) and compression (ASTM D642) or stacking strength (ASTM D4577). Each test may or may not be necessary for a particular packaging application. For example, vacuum testing will demonstrate if a seal is too weak to survive transportation in low pressure conditions such as air freight.

**Quality Assurance:** QA testing for food applications is very important for the safety of the consumer. These would include test such as permeability of the film (ASTM F1307, F1927, F372-73, D1434, F1769), migration (ASTM D4754), resistance to flex cracking (ASTM F392),or microwave testing (ASTM F1308, F1500, F1519). The use of a product determines the necessity of a particular test. For example, a package not intended to be put in the microwave by the consumer would not require a test for microwave volatiles. Any issues in QA testing may indicate previously unnoticed issues in the performance testing and should be addressed accordingly.

**End use group:** End use/qualitative testing is used to show that the peelable film is performing as intended. Peel strength testing will show if the force required to open the package is too great. For example, an elderly consumer may not have the hand strength to open the package. A second more ambiguous test is Peel quality test are used to find the percentage of seals produce angel hair or are welded to the container. This is accomplished by peeling large numbers of containers, and recording the number of unsatisfactory peels. End use tests, while ambiguous, help a company judge whether a peelable film is truly performing and functioning as was originally intended for the customer.

## Conclusion

The current use of peelable films in the packaging industry makes packages much more consumer-friendly. There are many factors to be taken into consideration when designing, implementing, and testing a new package. The machinery used in all steps of manufacturing a peelable package have an influence on the finished product. All of these obstacles are more difficult if an existing package is being modified to fit peelable technology. All the issues addressed here are not always present, but a company that is prepared will be able to address any issues in a fast and cost efficient manner.

Packaging science has always, and will always be, the joining of many scientific disciplines. With the development of new machinery to handle these technologies, the production of peelable films will become faster and cheaper. Peelable film technology has progressed in recent years, and its applications in the future are endless.

**Work Cited**

"Detecting Defects." Packaging News (2008): 47. LexisNexis Academic. 10 Dec. 2008. Keyword: Peelable film packaging news.

Dodrill, Dhuanne. Advances In Peelable Sealant Technology. Tech. Rollprint Packaging Products, Inc. 10 Dec. 2008 <http://www.rollprint.com/PDF/RPP_IoPP_2005.pdf>.

Marotta, Carl. "Medical Packaging." Wiley Encyclopedia of Packaging Technology. 2nd ed. New York: John Wiley & Sons, 1997. 610-15.

Miller, Adolph. Converting for Flexible Packaging. Lancaster, PA: Technomic Company, Inc., 1994.

Petrie, Glenn. "A Comparison of Heat Seal Coating and Peelable Film Technologies for Medical Packaging." Medical Device & Diagnostic Industry Magazine Jan. 2000.

Medical Device Link. Jan. 2000. 5 Dec. 2008 <http://www.devicelink.com/mddi/archive/00/01/013.html>.

Soroka, Walter. Fundamentals of Packaging Technology. 2nd ed. Richard Warrington, 1995.