TECHNICAL BULLETIN:
PEELABLE AND COHESIVE SEALS

1) Introduction

One of the main goals for plastic packaging converters after determining end requirements and designing the appropriate structure to meet shelf life product, is keeping packaging effectiveness. Parameters such as stiffness and thickness play an important role in achieving these objectives; however, the seal effectiveness will determine the success and quality of final packaging [1].

Seal strength is an important feature in plastic packaging films because it helps to define how easy or hard the package can be opened. In some cases, a low value of seal strength is desirable because an easy manual opening of packaging in these applications is required, while in other applications a strong and hermetic seal is required to leave evidence of its rupture.

This technical bulletin aims to provide information about these two types of seals from which plastic packaging films can be designed. They are associated with type of failure that occurs during its opening, and are classified as follows: *peelable seal*, when an adhesive failure occurs, and *cohesive or permanent seal*, when a cohesive failure occurs in seal structure.

2) Failure Mode

2.1 Peelable seal (adhesive failure) [2].

The peelable seal or adhesive failure (Figure 1) is caused when seal's opening occurs in adjacent layers without any tearing of the polymer film.

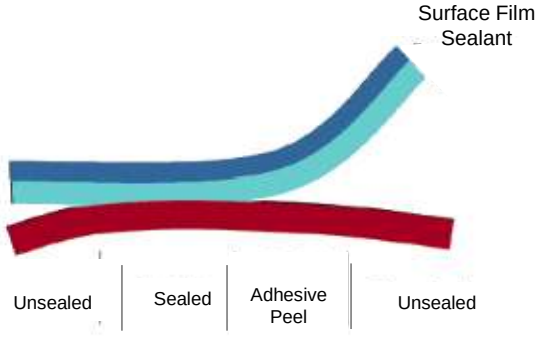

Figure 1. Peelable seal [2].

Currently, manufacturers of packaged products are meeting the demand for easy-opening packages by adopting peelable seals for a growing number of products. The importance of this type of seal is that provides easy opening without compromising package integrity along the product distribution chain [3].

In addition to its easy-open feature, one of the main advantages of those packaging designed under this seal type is that the opening does not leave any kind of residue, which is unpleasing to consumer [2].

2.2 Cohesive Seal

Unlike peelable seal, in this type of seal separation occurs inside the sealant layer (Figure 2), where the required separation force is determined by the material inherent strength, resulting in increased seal strength and a more hermetic package [3].

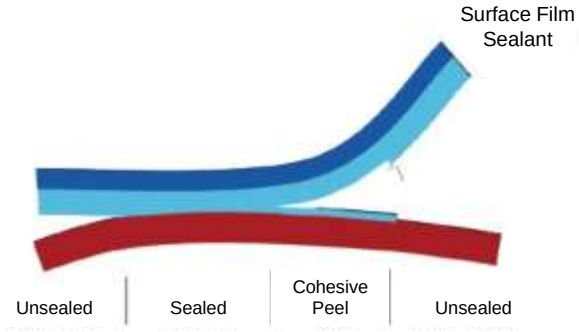

Figure 2. Cohesive seal [2].

Sealant layers in cohesive seals have the disadvantage of exhibiting a greater thickness than films designed with peelable sealant layers, because of such layers must be thick enough for sealing and having space to fail inside them. Thickness variations along package can cause problems on packaging line, so it is important to control this factor when designing and manufacturing these products [2].

3) Factors affecting the seal in automatic packaging [1].

3.1.1 Seal initiation temperature (SIT)

SIT indicates the minimum temperature required to obtain an acceptable seal. It is typically the temperature at which about 60% to 80% of the polymer structure melts. This parameter is associated with the film residence time in sealing machine. The lower this value the faster sealing machine can operate, leading to lower energy consumption per package. Materials such as EVA (Ethylene Vinyl Acetate) and ULDPE (Ultra Low Density Polyethylene) are commonly used in blends

with other types of polyethylene or polyolefin to improve this property.

3.1.2 Seal Window

Seal window or seal range is a parameter that correlates with packaging behavior in a sealing machine. Sealant layers intended for applications with peelable seal or cohesive seal must be designed so that their window seal is as wide as possible to ensure effectiveness of seal in presence of usual variations of the product packaging process.

Figure 3 shows a typical sealing curve highlighting the parameters previously described.

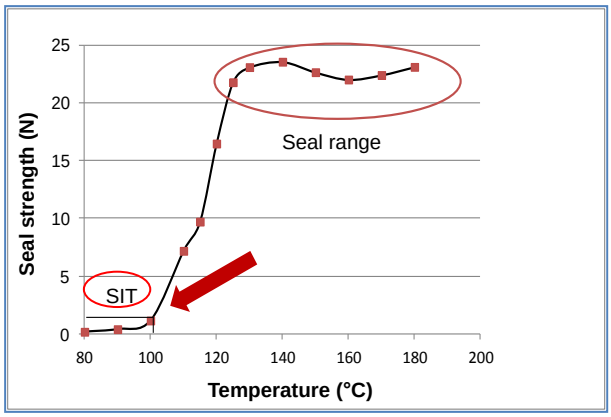

Figure 3. Typical seal curve of a flexible packaging.

There are other factors affecting the packaging seal opening strength. These factors include [2]:

- Stiffness of package structure.
- Seal surface.
- Sealing parameters (temperature, packaging line speed).
- Aging.

According to references [1,3], typical seal strength on easy-open packaging for food and snacks oscillates between 500 g/2.5 cm and 1500 g/2.5 cm; while in more demanding applications such as medical, pharmaceutical and industrial packaging that require greater hermetic properties (cohesive seal) with high seal strength values are above 2500g/2.5 cm.

4) Applications

Packaging used for food storage, medicines, industrial products, etc., need to be hermetically closed (sealed) to protect the product from environmental and shelves exposure conditions on markets where they are sold. New structures design plays a key role in seal integrity and its requirements are based on the product final application.

Development of new structures [4] to satisfy high requirements of the packaging seal properties has been growing for many applications. Field studies conducted by Polinter and Indesca indicate that it is possible to use polyethylene to develop a reliable seal to ensure product integrity.

4.1 Peelable seals

Seal strength in applications which require peelable seals is controlled by sealant layer composition.

Packaging with peelable seals requires incompatibility between polymeric materials used in their sealing layers. This feature prevents the development of a full sealing bond, which reduces the number of available sites for connections on film surface. It also causes poor interfacial adhesion which reduces inner bonding strength [5].

Table 1 shows typical peelable seal structures with good performance. The peelable seal layer usually represents between 15% and 20 % of the structure total thickness.

Table 1. Peelable seal structures

Sealant layer	Composition
1	LDPE+PP+ULDPE
2	LLDPE+LDPE+PP+ULDPE
3	LLDPE+ULDPE+EVA+PP

Among attributes that justify using these materials are following:

- LDPE (Venelene® FA0240): low SIT. Excellent processability and transparency.
- LLDPE (Venelene® 11PG1): excellent mechanical and optical properties. High hot tack seal strength.
- ULDPE (ultra low polyethylene density): low SIT. It is used to increase seal temperature difference

between polyethylene layers of seal structure and "contaminant" agents.
• PP: acts as incompatible agent (or "contaminant") to prevent seal strength values above required.

Main applications for this seal type are:
• Packaging for processed meats, bacon, sausages, sliced meats, different kinds of cheese.
• Packaging for cereals, candy bars and snacks.
• Removable lids containers: yogurt, frozen meals.

4.2 Cohesive or permanent seal

Many medical applications employ this type of hermetic seal to prevent access of microorganisms inside packaging [6]. Similarly, some industrial applications packages require high seal resistance to withstand mechanical requirements to which products are exposed during packaging and transportation.

In previous years [7,8], Polinter and Indesca have developed structures for industrial and automatic applications using 100% polyethylene resin Venelene® in all layers (including sealant layer), mainly composed of LDPE/LLDPE blends, which have guaranteed strength and an adequate window seal to meet application requirements.

Commercial grades of Polinter used for industrial and automatic packaging structures are shown In Table 2.

Table 2. Cohesive seal structures.

Application	Composition
Industrial packaging	LDPE Venelene® FB3003 / LLDPE Venelene® 11PG1
Automatic packaging	LDPE Venelene® FA0240 or FD0348 / LLDPE Venelene® 11PG4

In this case, attributes that justify the use of these materials are:

Industrial packaging:
- Venelene® FB3003: excellent processability and mechanical properties.
- Venelene® 11PG1: excellent mechanical and optical properties. High hot tack seal strength.

Automatic packaging:
- Venelene® FA0240 and FA0348: excellent processability and transparency. Low SIT.
- Venelene® 11PG4: excellent mechanical and optical properties. High hot tack seal strength. Good slidability and low friction between polymer and metallic materials involved in packaging process.

5) Emerging trends (3, 9, 10, 11)

Rigid containers, tubs and other products with removable covers represent the main areas in easy-open packaging (Figure 5).

The main products categories using removable lids containers are:
• Refrigerated products such as: butter, margarine, yogurt, pudding and cream cheese.
• Shelf-stable products such as noodle soup and ready-to-eat meals (without refrigeration).
• Non-food products such as wipes and OTC (Over the Counter) drugs.

Figure 4. Emerging trends in easy-open packages [3].

Another trend in peelable seals area is related to food packaging for microwave cooking. They offer a special peeling seal that helps customers to prepare dishes directly in the package.

This new application allows pressure accumulated during heating to promote steam generation inside package, which contributes to get a better food cooking. The package opens at the exact time when the food ideal temperature condition is reached. Parameters such as opening and seal strength are ideally adapted to cooking time.

This package is ideal for the following foods (Figure 6):

- Baked potatoes
- Soups and vegetables
- Pasta
- Sauces

Figure 5. Packages for microwave cooking [9].

Moreover, development of reclosable technology for flexible packages saves packaging materials (Figure 7). These packages use a robust adhesive technology that allows consumers to easily open and close the package several times without compromising its integrity. This new technology offers a positive experience for users, since it enables the consumption of the product in quantities and frequency desired.

Figure 6. Reclosable package [10].

Regarding cohesive seal types stands out the ultrasonic seals technology (Figure 8). In this type of sealing, the fusion heat (sealing) is generated inside the polymer sealant layer, and not from the outside as conventional seal methods. Thus, heat dissipation to outside become faster, promoting higher hot tack seal strength in films tested. One of the main advantages of this method is that it enables a reliable seal quality, even in dusty environments during packaging process.

Figure 7. Package with ultrasonic seal [10].

6) References:

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This bulletin has been made by the Marketing Department of Poliolefinas Internacionales, C.A. (Polinter) with technical support of Investigación y Desarrollo, C.A. (INDESCA).Caracas, Venezuela, in June, 2015.

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The information described in this document is accurate and reliable to our best knowledge. However, since the particular uses and processing conditions are completely out of our control, the setting of the processing variables in order to reach the maximum performance of our products for a specific application depends on and it is responsibility of the user.

In order to obtain more detailed information of the security aspects regarding the use and disposal of our products, we invite you to consult the material safety data sheets (MSDS) for Venelene® polyethylene.