

BULLETIN: VENELENE® OCTENE POLYETHYLENE (TUBULAR FILM)



1 Introduction

The application of films represents one of the first commercial uses given to the Polyethylene and the segment of greatest demand in these resin markets.

From the developments of linear Polyethylene in the decade of the sixties and with the expansion of its commercial use during the seventies, a technological evolution process has taken place directed towards improving the performance regarding the processing and properties of this family of products.

Unlike the case of low-density Polyethylene obtained in the high pressure process, a second monomer unit is incorporated for obtaining linear Polyethylene (*Monomer: Minimum chemical unit which constitutes a polymer molecule*) that allows the product density control. This second monomer unit is called comonomer; while the polymers that have at least two different monomer units are called copolymers.

Commercially, linear Polymer production technologies primarily use three types of comonomers:

- Butene or Butylene: Is widely used in the manufacture of low-density linear Polyethylene, with special participation in the product segment for applying films. It stands out due to its flexibility offered for obtaining a wide variety of products as well as their lower cost.
- Hexene: Its use is much less spread out than the case of Butene. It allows obtaining linear Polymers with better properties than those obtained with Butene copolymers. The cost of Hexene copolymers is higher than Butene copolymers.
- Octene: The use of Octene is less disseminated than the previous monomers. The Octene copolymers exhibit better properties than the Hexene and Butene based products, and likewise, have a higher cost.

The Sclair® technology used by Polinter for obtaining its linear Polyethylene allows the use of both Butene as well as Octene comonomers.

The growth in the demand of linear Polyethylene for film applications, the expansion of export markets and the constant development of new and more sophisticated packaging structures have favored the commercial introduction of its new Venelene® Octene copolymer line.

The incorporation of this new line of products will allow our clients to obtain a better performance in terms of productivity and quality due to the superiority of the octane copolymers regarding:

- Resistance to Tearing.
- Impact and penetration resistance.
- Hot Tack and cold seal resistance.
- Seal flexibility (Flex Crack) and resistance to the generation of Pin holes.



New Venelene® Octene for films.

With the purpose of satisfying the rigorous quality and productivity standards that require our clients, leaders in the competitive film extrusion market, Polinter has developed two new degrees of copolymerized PELBD with Octene under the commercial references: Venelene® 1101 and 1104.

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The Venelene® 1101 and 1104 products have been designed to meet important improvements in those parameters which directly contribute to:

- 1) Increase in productivity:
 - a) Decrease in production stoppage due to falls or ruptures of the sleeve extrusion.
 - b) Less frequency of the size of packaging.
 - c) Greater forming, filling and sealing production speed (FFS – Form, Fill, and Seal).
- 2) Manufacturing costs reduction:
 - a. Use of films of lesser thickness.



The Venelene® 1101 and 1104 products fulfill the following general properties:

Properties	ASTM ⁽¹⁾	Unit	Typical Value ⁽²⁾	
Melt Flow Index (190°C - 2.16 Kg.)	D1238	dg/min	0.90	
Density	D792	g/cm ³	0.918	
Mechanical Properties under Tension⁽³⁾				
Toughness	D882	MPa	MD	TD
Tensile Strength	D882	MPa	160	145
Tensile Elongation	D882	%	55	44
Elmendorf Tearing	D1922	g	760	850
Impact Resistance	D1709	KJ/m	1000	1650
Puncture Resistance	-	g	53	
Optical Properties (3)				
Luminous Transmittance	D1003	%	85	
Haze	D1003	%	5	

⁽¹⁾ Covenin standards are equal to those ASTM applied: Covenin 461-96 Density; Covenin 1152-93 Fluidity Index and Covenin 1357-79 Mechanical Properties.

⁽²⁾ Typical values comprises of the media obtained in Lab, which are herein shown as reference only and not as specifications.

⁽³⁾ Properties measured on 35-micro thick film.

Both references have stabilization process and assistance systems, especially chosen to guarantee an excellent performance of its products during the transformation and usage stages. The Venelene® 1104 also has sliding and anti-blocking additives in order to satisfy the application requirements of automatic packaging.

2 Processing

The copolymerized PELBD with Octene may be processed (pure or in PEBD mixtures) under similar conditions to the ones applied with Butene or Hexene copolymers. Nevertheless, in order to achieve an optimal performance and excellent optical qualities, it is advised to use extrusion temperatures between 10 to 20°C higher than those applied to Butene copolymers. Under these extrusion conditions, the outstanding bubble and termooxidativa stability of the Venelene® 1101 and 1104 allows to obtain films of unsurpassable appearance and quality.

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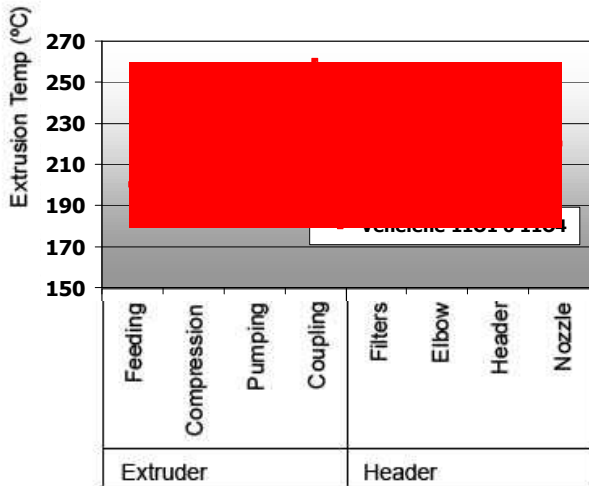


Figure 1. Suggested extrusion temperature profile for linear Octene and low density major mixtures.

A relevant attribute in the Venelene® Octene polymers processing is their lesser tendency to the presence of flow lines or the fracture of the melted material. This comparative advantage is the result of a formulation based on "Processing Assistants" of the Fluoroelastomer category, especially designed for this family of Venelene® products.

3 Mechanical properties

As it was mentioned in the introductory section, the incorporation to the Octene comonomer Polyethylene increases the mechanical and sealing properties with respect to the copolymerization with Butene.

By way of illustration, the results obtained in the industrial film assessment for all ice bags have been taken, traditionally manufactured with a major mixture in PEBD (Venelene® FB-3003) with PELBD copolymerized with Butene (Venelene® 11F1).

Figure 2 shows that a resistance to penetration obtained with the incorporation of the Octene copolymer is greater in 25% to the mixture made with the Butene copolymer (Venelene® 11F1). It can be seen in the same figure how the use of

Octene allows a thickness reduction, in this case, up to 20% maintaining a greater resistance to penetration in 15% to the mixture with Butene PELBD.

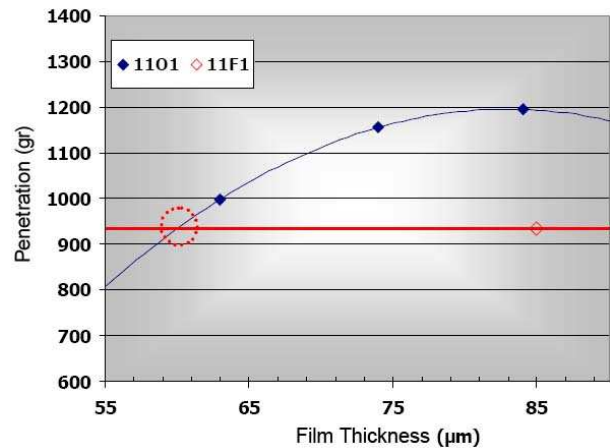


Figure 2. Variation in resistance to penetration of PELBD Octene / PEBD films vs. the mixture with Butene PELBD.

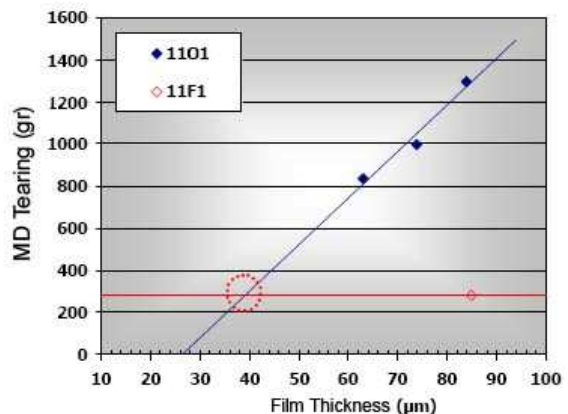


Figure 3. Variation in Resistance to Tearing in the extrusion direction (MD) of PELBD Octene / PEBD films vs. the mixture with Butene PELBD.

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Figures 3 and 4 illustrate the outstanding tear behavior that can be achieved by the use of Octene copolymers.

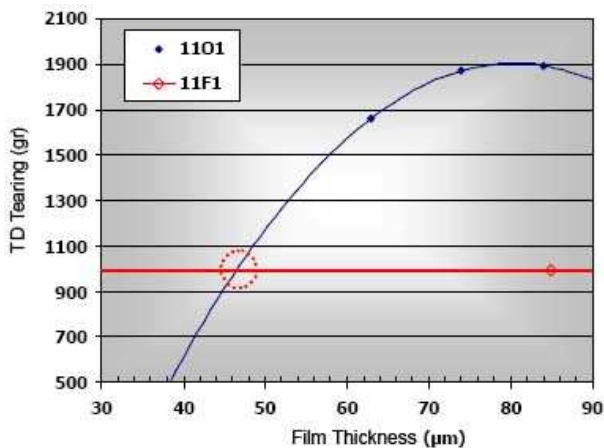


Figure 4. Variation in Resistance to Tearing in the transversal direction (MD) of PELBD Octene / PEBD films vs. the mixture with Butene PELBD.

The results represented in this example indicate that even with the reduction by 15% of the film thickness, the Resistance to Tearing in both directions is greater by 50% to the film produced with a mixture made up of butane copolymer.

One of the most valued attributes of the Octene copolymers is their outstanding sealability.

Figure 5 compares the hot seal resistance (property most widely known by its English term: Hot Tack) of the Venelene® 1101 Octene copolymer and the Venelene® 11F1 and 11U4 Butene copolymers. As it is demonstrated by the data, the seal resistance achieved by the incorporation of the Octene product in a PEBD mixture is a 100% higher than the mixtures with Butene PELBD. Additionally to the elevated seal resistance, the use of Octene copolymers allows the shaping of the seal at lower temperatures (between 10 to 20°C).

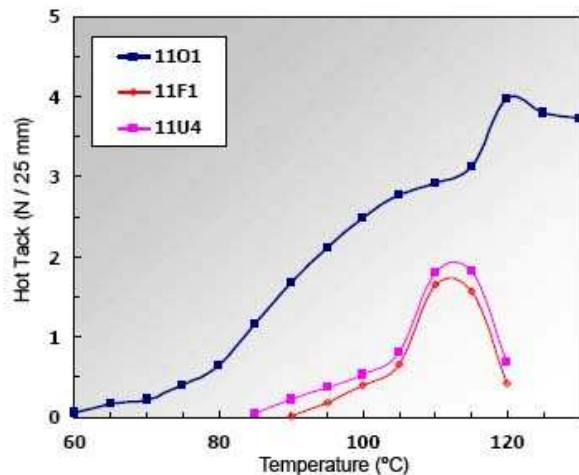


Figure 5. Hot seal resistance (Hot Tack) of PELBD Octene / PEBD films vs. the mixture with Butene PELBD.

The combination of a high resistance of the seal together with low temperatures for shaping give the users of film made with Octene copolymers the advantage of operating the forming – filling – sealing (FFS) lines at substantially greater velocities to the ones using Butene copolymers, which will result in lower packaging operational costs.

4 Cost Optimization – Properties

In spite of a greater commercial value, Octene copolymers exhibit advantages in their mechanical and sealing properties that allow the development of structures with a high performance and costs equal or lower to those achieved with films in which Butene copolymers are used.

The case described hereunder is of a laminated structure for packaging food products, traditionally manufactured with a Venelene® FA-0240 mixture (basic component) and the Venelene® 11Q4 PELBD (Butene).

As an alternative for testing, a mixture of a ternary mixture made up of the Venelene® 1104 PELBD (Octene), Venelene® 11Q4 PELBD (Butene) and Venelene® FA-0240 PEBD.

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Figures 6 to 8 illustrate similar trends to the ones already shown in the previous example; according to which, the incorporation of the Octene copolymer allows the reduction of the film thickness between 10 and 15 micron, thus guaranteeing the same or a higher mechanical performance level than the one obtained with the major PEBD – PELBD (Butene) mixture.

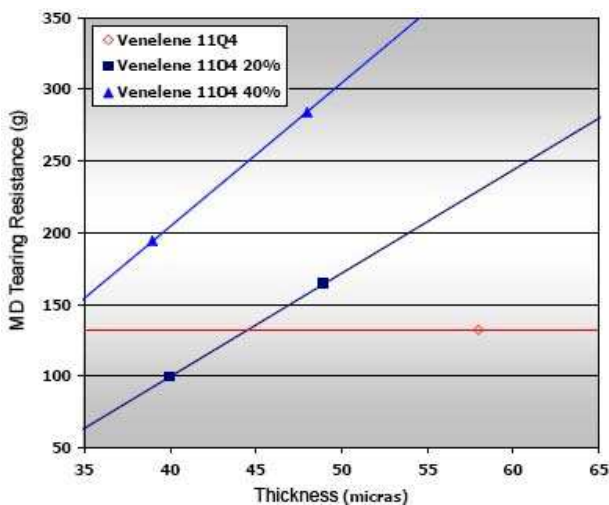


Figure 6. Resistance to Tearing (extrusion direction - MD) of PELB Octene / Butene / PEBD films vs. the mixture with Butene PELBD.

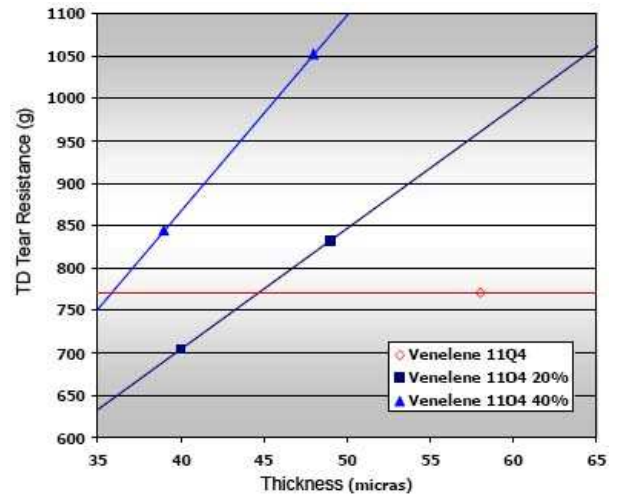


Figure 7. Resistance to Tearing (transversal direction - MD) PELBD Octene / Butene / PEBD films vs. the mixture with Butene PELBD.

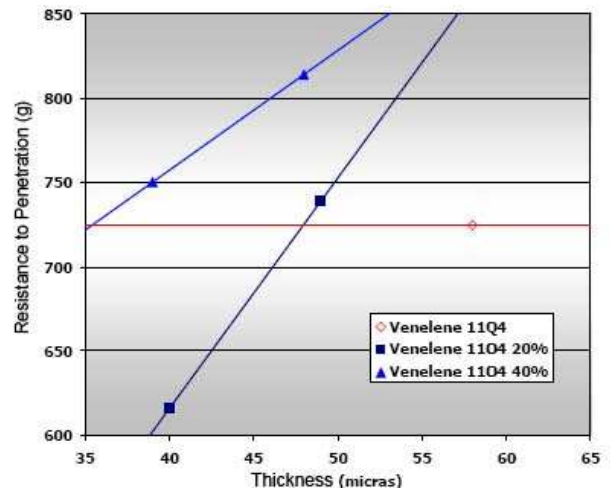


Figure 8. Resistance to PELBD Octene / Butene / PEBD film penetrations vs. the Butene PELBD mixture.

In order to assure that the major mixtures in Linear Polyethylene satisfy the demands of the automatic packaging application analyzed in this case, a haze and brightness measurement of the obtained films was carried out.

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Figures 9 and 10 show how the assessed ternary mixtures exhibit similar or greater transparency and brightness properties to the major mixture in PEBD traditionally used in the application.

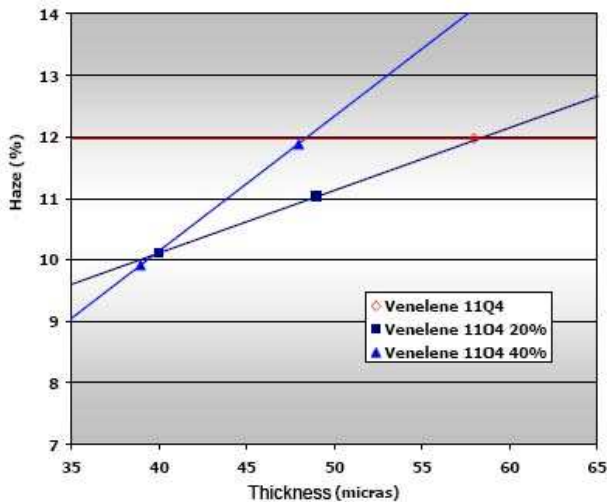


Figure 9. Haze of PELBD Octene / Butene / PEBD films vs. the Butene PELBD mixture.

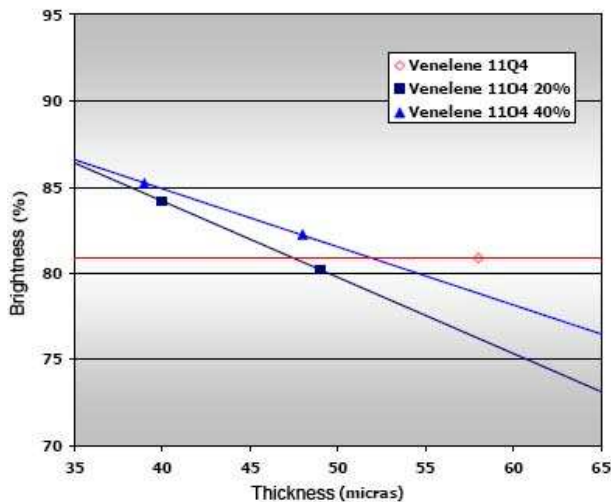


Figure 10. Brightness of PELBD Octene / Butene / PEBD films vs. the Butene PELBD mixture.

Additionally to the hot seal lab tests (see figure 11) which ratify the outstanding sealing behavior of the films to which an Octene copolymer was incorporated. Performance evaluations of the

mixtures sealing were carried out during the packaging operation FFS.

The incorporation of octene to the ternary mixture allowed an increase of the forming – filling – sealing line speed in 20%, further evidencing the improvement in the package seal quality.

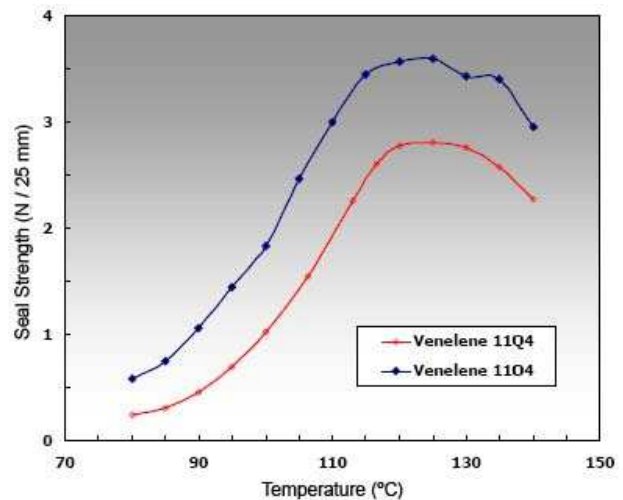


Figure 11. Hot seal resistance (Hot Tack) of PELBD Octene / Butene / PEBD films vs. the Butene PELBD mixture.

Having established the advantages in the use of the ternary mixture with respect to the PEBD / PELBD (Butane) mixture, the cost evaluation of the film was carried out, taking into consideration the contribution of the change in composition, decrease of thickness and the increase in productivity of the packaging line.

For the particular case of the Venelene® 11Q4 Butene PELBD, Venelene® 1104 Octene and Venelene® FA-0240 PEBD, the ternary mixture has cost differentials of raw materials with respect to the mixture being evaluated mainly made up of the Venelene® FA-0240 PEBD and PELBD 11Q4 range between -2.8% and 11.9%.

Based on the costs analysis carried out, a ternary mixture with 30% composition of the Octene copolymer was selected, which cost is slightly lower than the reference (0.7%).

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Considering the mechanic performance advantages of the ternary mixtures it was decided to reduce the film thickness by 15%, with the corresponding equivalence in packaging costs reduction.



Finally, with the use of the PELBD (Octene – Butene) mixture, the client achieved savings

between 15% and 30% in its film production and packaging integrated chain, as a result of:

- Savings in the composition of the mixture: 0.7% (the incorporation of a 30% Octene was compensated with a greater cost as raw material).
- Savings in thickness reductions: 15%
- Savings due to increase in the packaging line productivity: between 0 to 20% (the use of the costs due to an increase of the production speed differential is conditioned to the complete use of the line capacity by the client).

In conclusion, the recently described case illustrates how the use of the Venelene[®] Octene copolymers allow not only to satisfy the rising demand levels with respect to the performance of film applications; but also to capitalize important savings for the production, packaging and packaging.

Polinter places at its customers' request its technical assistance and research and development resources in order to provide support in the sustained improvement of their competitive position.

This bulletin has been made by the Marketing Department of Polinter with the support of the specialists of Investigación y Desarrollo, C.A. (INDESCA) and by the Technical Services Department of CORAMER. This is intended for all clients and users of the Venelene[®] resins and we trust that the information contained herein is helpful and useful.

Please contact us at the following email address, info@polinter.com.ve or through our agent: Corporación Americana de Resinas (CORAMER), with branch offices in Venezuela, Colombia, Peru, Ecuador and Chile (<http://www.coramer.com>), should you have any suggestions or comments regarding this issue.

The information described in this document is, to our best knowledge, accurate and truthful. However, since the particular uses and transformation conditions are completely out of our hands, the adjustment of the parameters in order to reach the maximum performance of our products for a specific application depends on and is the 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 security pages (MSDS) of the Venelene[®] Polyethylene.