ExxonMobil Chemical

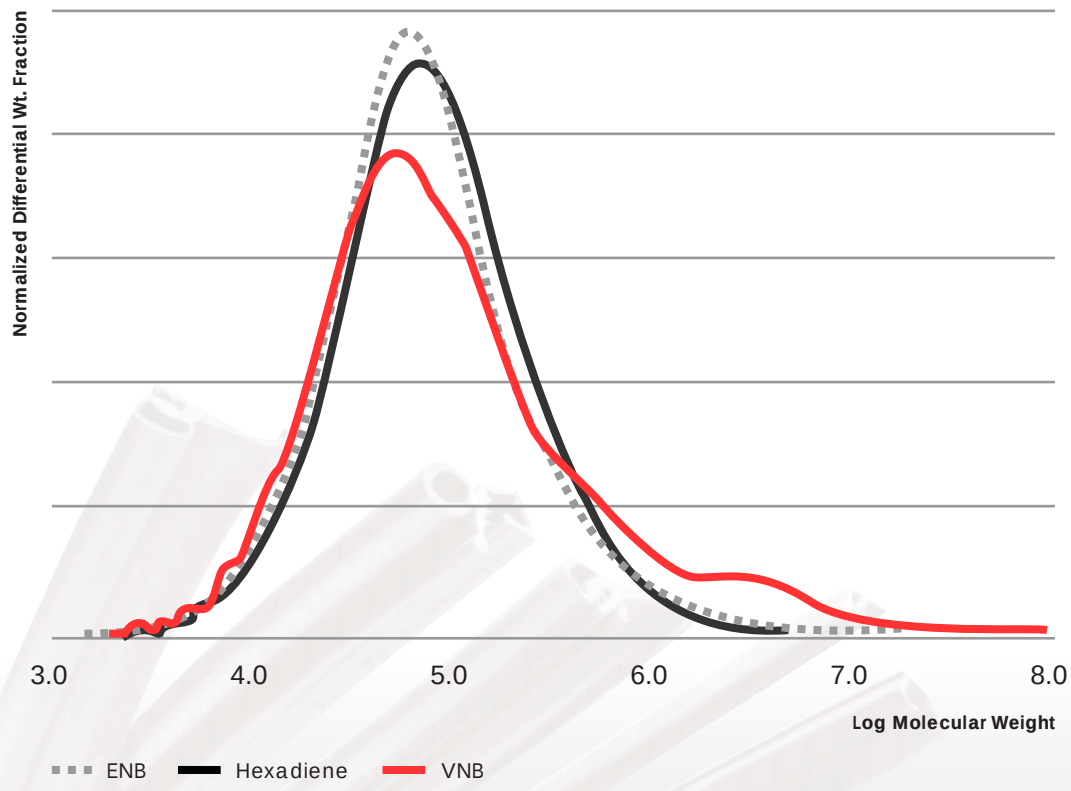
Vistalon 1703P EPDM for a New Generation of Medium Voltage Cable Insulation

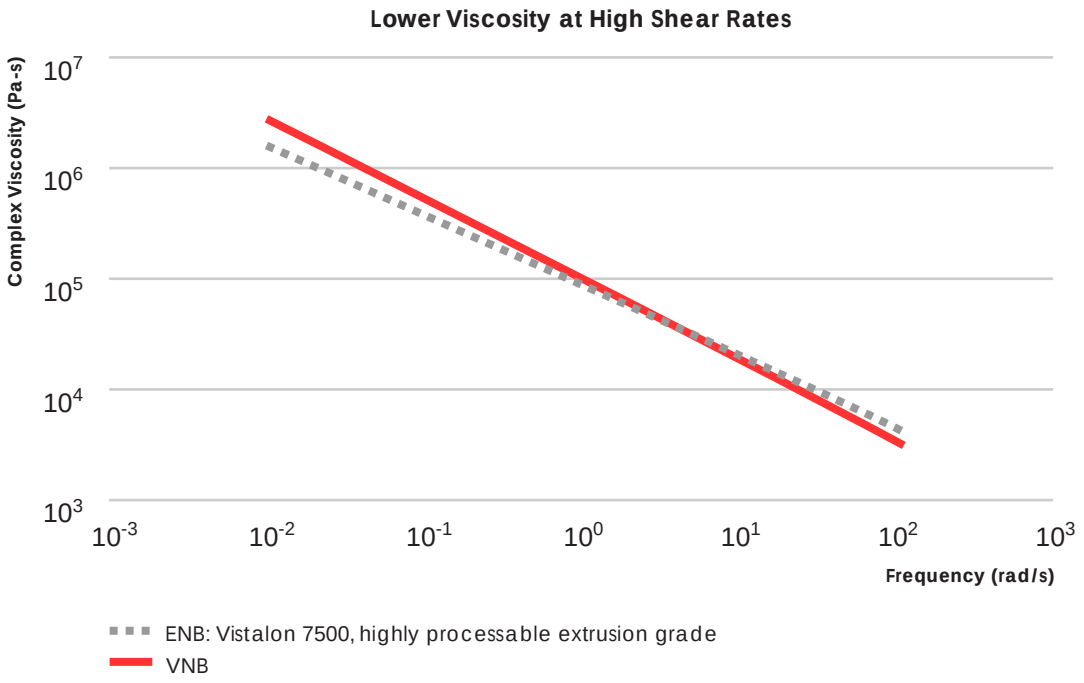
Vistalon 1703P is the first in a new generation of ExxonMobil Chemical EP(D)M rubbers utilizing a new diene, Vinyl Norbornene (VNB). VNB is an isomer of ENB (Ethylidene Norbornene) commonly used as the diene in EPDM. However, the pendant vinyl group in VNB has the tendency to incorporate in the polymer chain leading to uncontrolled polymerization and gelation.

A recent breakthrough at ExxonMobil Chemical has made it possible to overcome this limitation. A proprietary polymerization process allows the incorporation of significant amounts of VNB without gelation.

Vistalon 1703P contains about 0.9 wt % of VNB. This diene level is about twenty to thirty percent of the diene content in the EP(D)M currently used in the wire and cable industry.

Broad MWD Provided by VNB vs. Other Termonomers



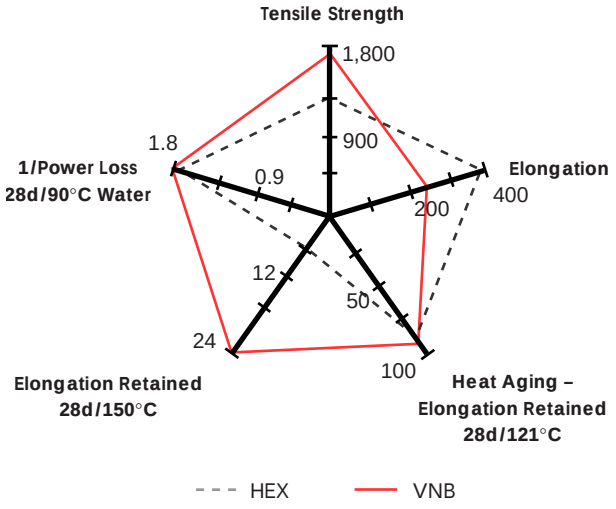


Typical Properties:

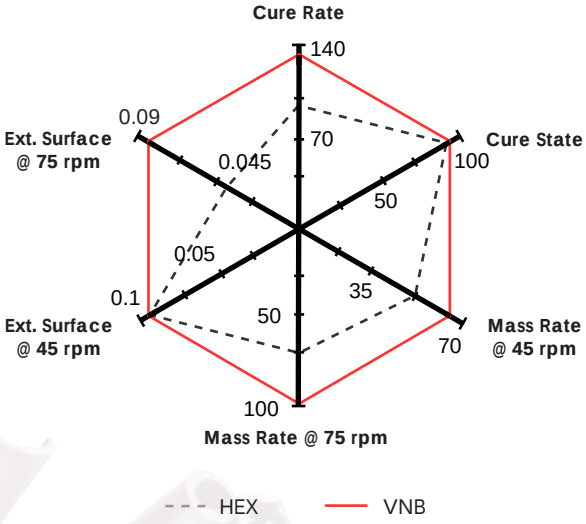
- Vistalon Grade Slate–Typical Properties

Medium Voltage Compound	phr
Vistalon 1703P	100
Calcined Clay	60
Zinc Oxide	5
Red Lead	5
Vinyl Silane	1
Antioxidant	1.5
Low density polyethylene	5
Paraffin Wax	5
Dicumyl Peroxide	5

Comparison of VNB and Hexadiene Compounds (60 phr Clay) – Physical Properties

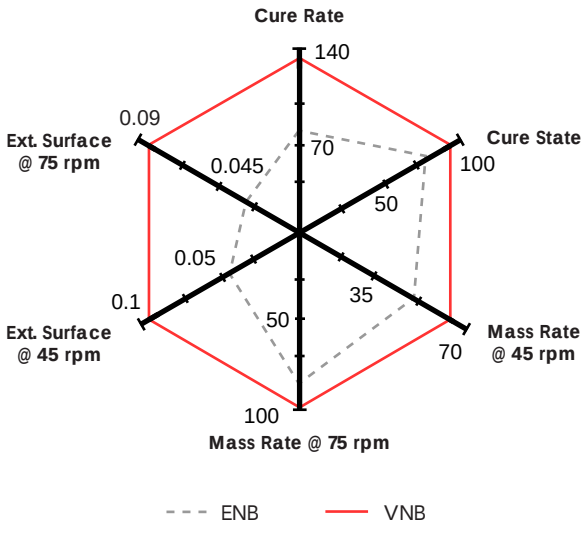


Comparison of VNB and Hexadiene Compounds (60 phr Clay) – Processability



ExxonMobil Chemical

Comparison of VNB and ENB Compounds (60 phr Clay) – Processability



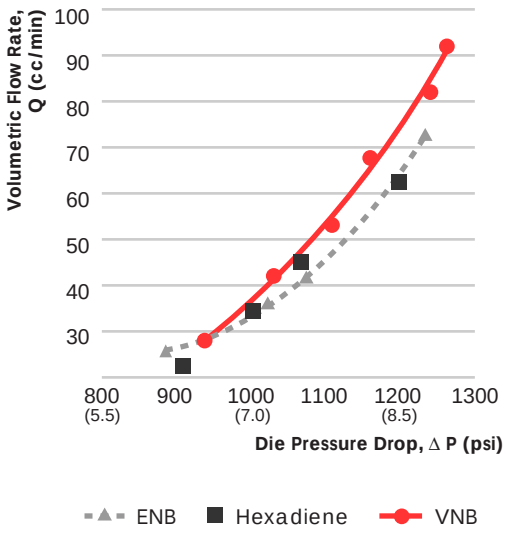
Easy processing

Vistalon 1703P makes wire and cable compounds easy to process, resulting in:

- High throughput at a given extruder RPM
- Low die pressure at a given throughput
- Smooth surface with low adhesion to the insulation shield for ease of stripping
- Potential to lower filler loading without melt fracture resulting in lower power loss.

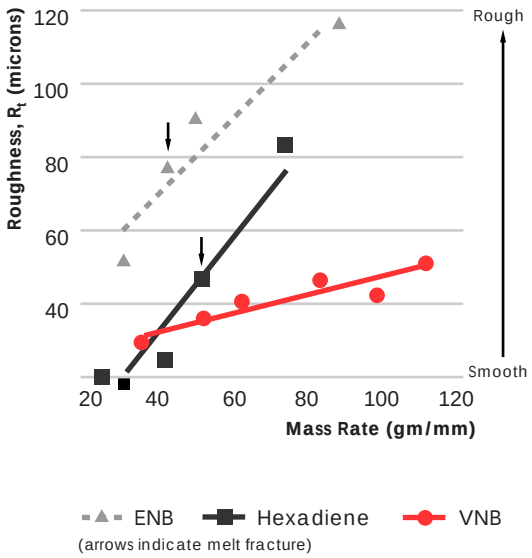
Variation of Flow Rate with Pressure Drop

60 phr clay



Variation of Roughness with Mass Rate

60 phr clay



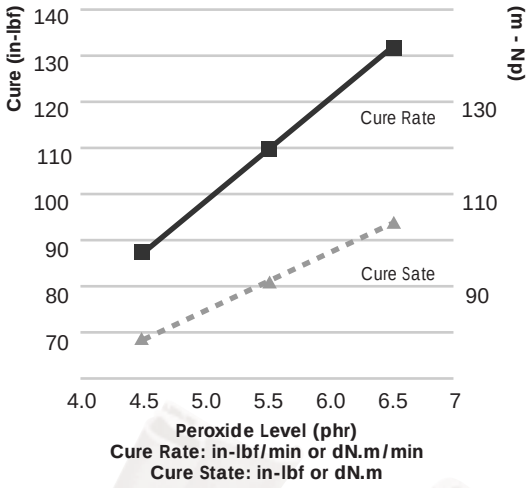
High crosslink density tailored for continuous vulcanization

Use of VNB as the diene in Vistalon 1703P leads to high crosslink density and fast cure rate at a fixed diene and peroxide level (Vistalon 1703P is not sulfur curable), when compared to other dienes in use today.

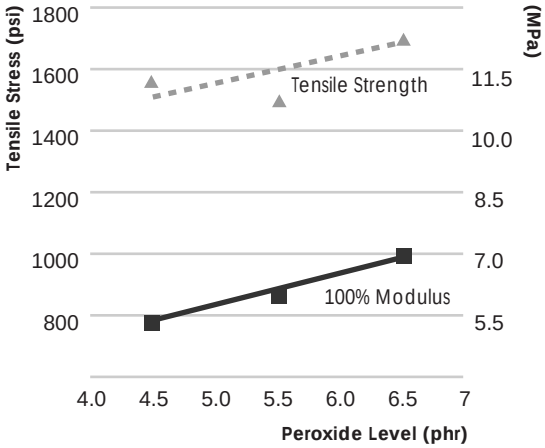
The fast cure rate is especially advantageous in the continuous vulcanization (CV) extrusion of cable insulation. In CV, there is a need to match high extrusion throughput with fast cure development to maximize cost effectiveness.

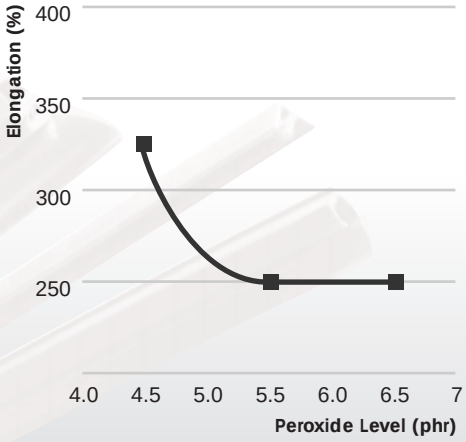
The high crosslink density is advantageous for good electrical properties but physical properties, such as elongation to break, can be adversely affected. Therefore it is important to optimize the peroxide level to obtain the right balance between crosslink density and good physical properties.

Variation of Cure Properties with Peroxide Level



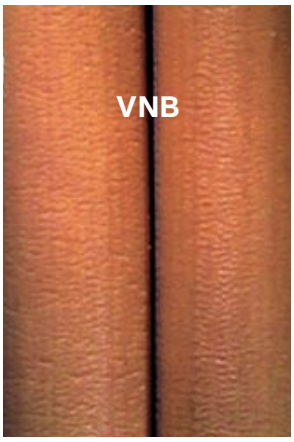
Variation of Physical Properties with Peroxide Level in 60 PHR Clay VNB Compounds





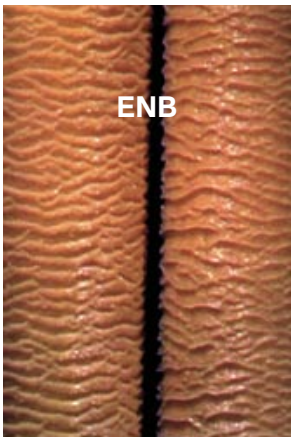
ExxonMobil Chemical

Extrudate Appearance – 45 phr Clay



Smooth

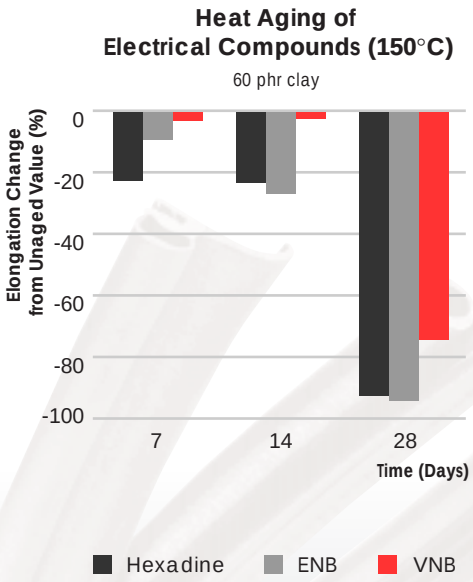
Coarse

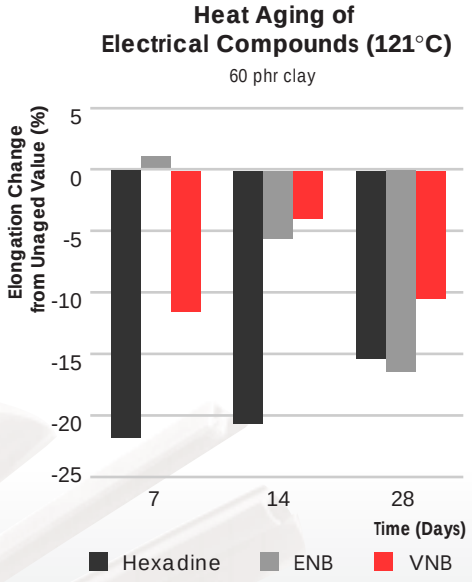


Very Coarse

Excellent heat aging

The low diene content of Vistalon 1703P combined with the need for lower curative levels leads to exceptional retention of physical properties even after prolonged aging at 150°C.





ExxonMobil Chemical

Low electrical loss

Vistalon 1703P is exceptionally clean. Properties associated with the VNB molecule allow for the manufacture of this polymer in a clean environment with ultra-low levels of metal residues such as calcium, vanadium and iron. This leads to improved wet electrical properties.

7000 Hours Wet Electrical Test

Polymer	Vistalon 1703P	Hexadiene
No. of Trees, (n)	24	77
Average Tree		
Length, 1 mm	0.047	0.17
Tree Severity (nxl)	1.13	13.09