

High Performance LLDPE Based Formulations for Blown Film Applications Requiring Superior Strength

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High Performance LLDPE Based Formulations

Discussion Topics

- 1 Comparing Properties of High Performance LLDPE Resins
- 2 Blending Study – Butene LLDPE in Higher Performance LLDPE



North American Markets Consuming High Strength Polyethylene Film Resins

Primary High Strength LLDPE Film Markets	Total LL Volume (MM lbs.)
Consumer & Institutional Can Liners	1700
Heavy Duty Films	1600
Shipping Sacks, Industrial Liners,	
Construction Film	

Combined Sources: 2011 Mastio Film Study, 2012 PTAI HAO Film Study, ACC LL Industry 2011

Lab Blown Film Blending Study – Monolayer Films

Purpose:

- To Compare Various Types of High Performance LLDPE Film Resins
- To Determine the Effect of Blending Butene LLDPE into High Performance LLDPE Resins

All Films Produced on a Monolayer Lab Line Under the Following Extrusion Conditions:

- 6-inch Die with 100-mil Die Gap
- 1-mil Thickness
- 120 lbs./hr.
- BUR = 2.3
- Frost Line = 24”
- Typical LLDPE Temperature Profile (~425 F Melt Temperature)

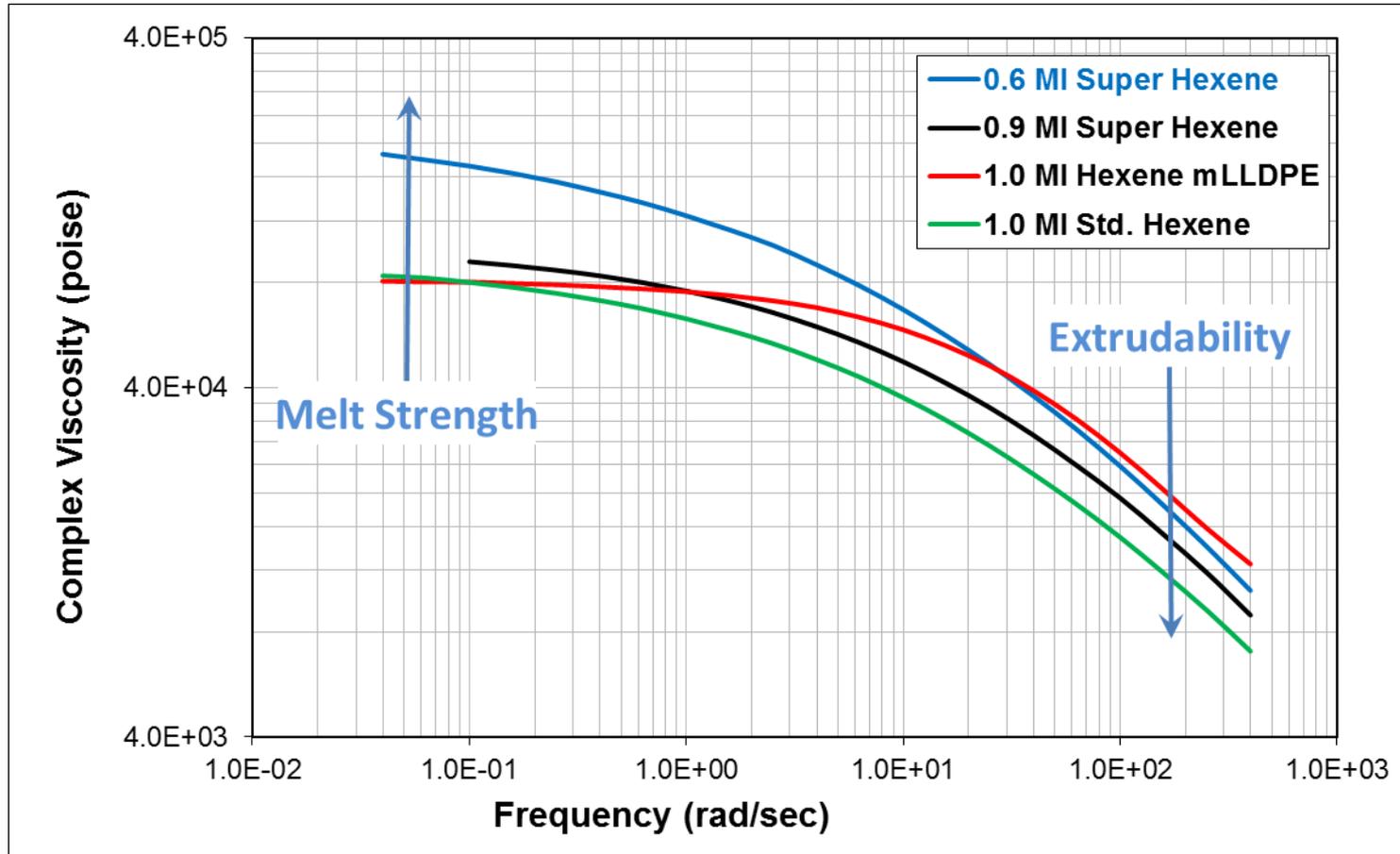
Resins Studied

Resin Type	Melt Index (g/10 min)	Density (g/cc)
Super Hexene	0.6	0.9165
Super Hexene	0.9	0.9165
Hexene mLLDPE	1.0	0.918
Standard Hexene	1.0	0.918
Standard Octene	1.0	0.918
Standard Butene	1.0	0.918

High Strength LLDPE Film Resins

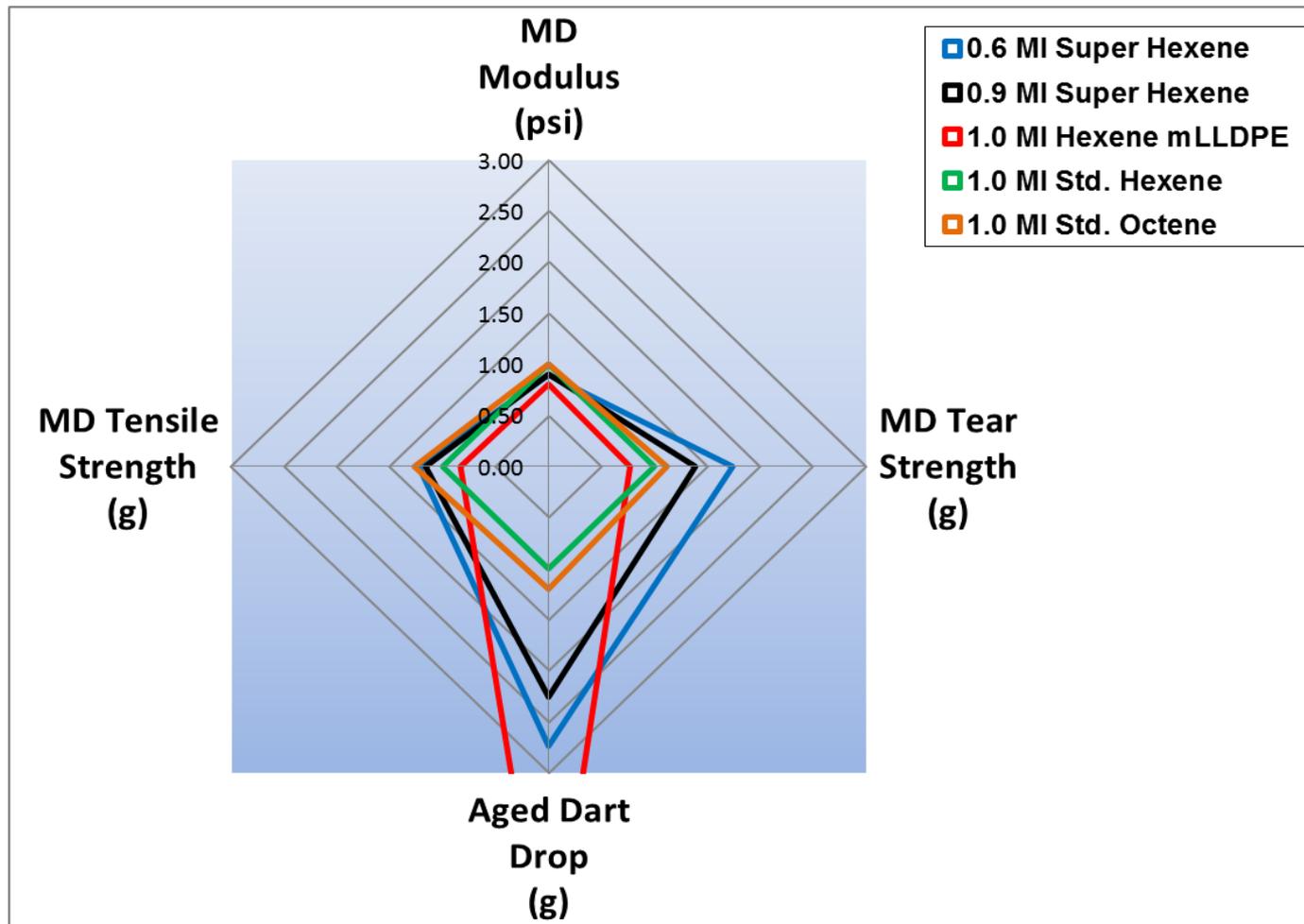
Blown Film Processability Comparison

Fractional MI Super Hexene resin demonstrate high melt strength to support excellent bubble stability at high output or film gauge



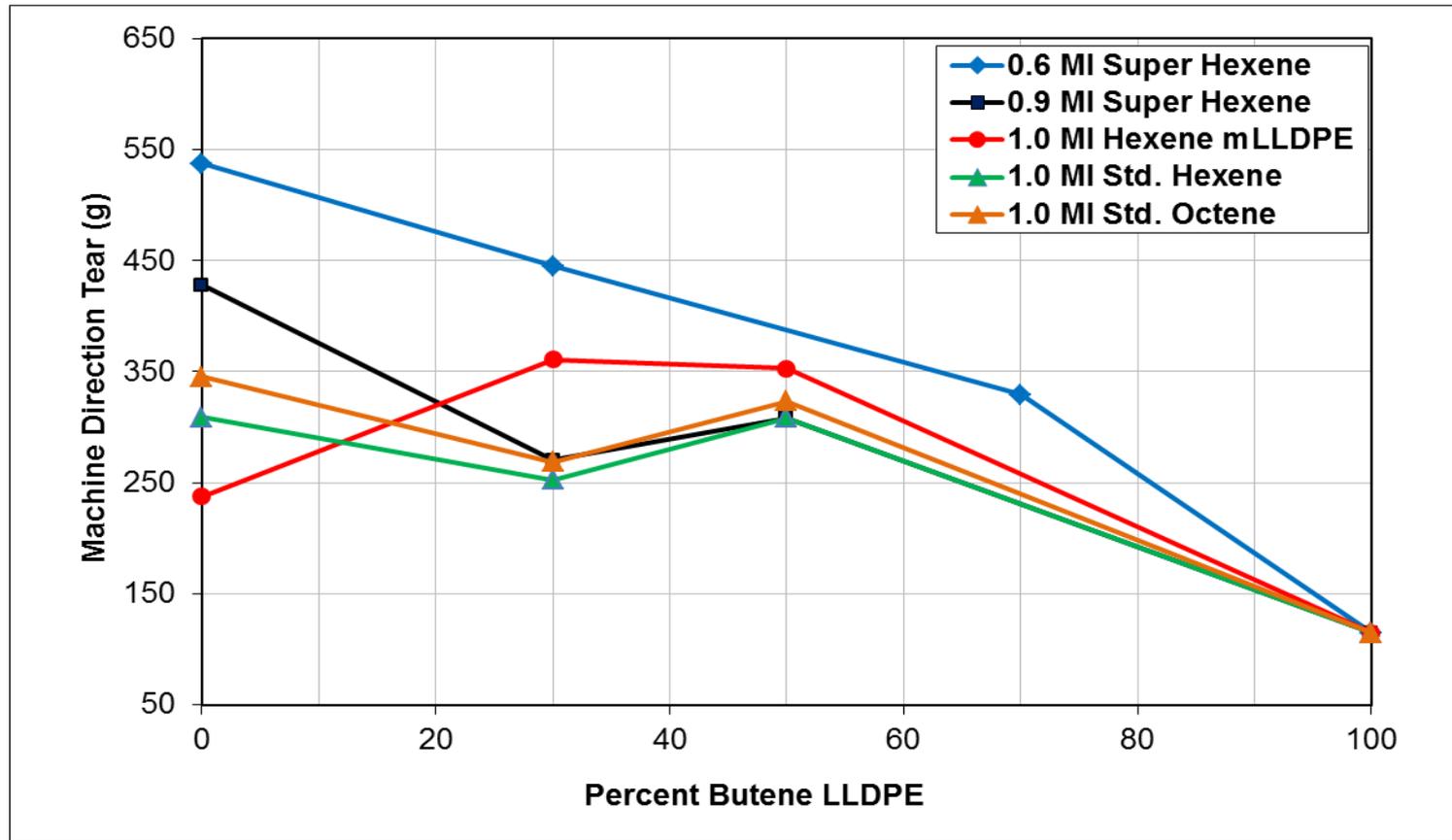
High Strength LLDPE Film Resins Physical Property Comparison

Super Hexene resins offer a good balance of physical properties



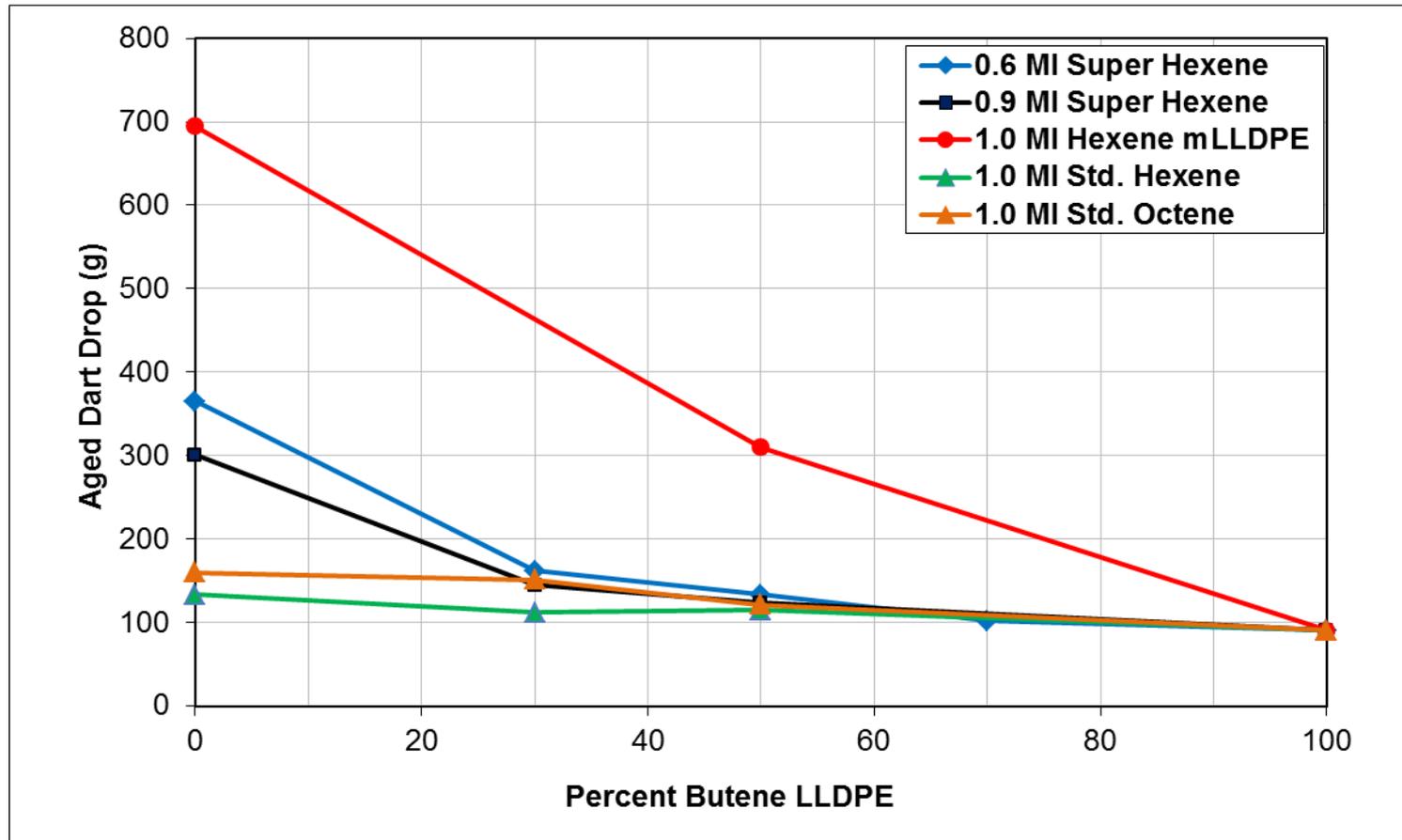
Machine Direction Tear Strength vs. % Butene LLDPE

- Super Hexene resins demonstrate high tear strength required in high strength film applications
- Blends of fractional MI Super Hexene with Butene LLDPE can retain MD tear advantages



Aged Dart Drop Impact Strength vs. % Butene LLDPE

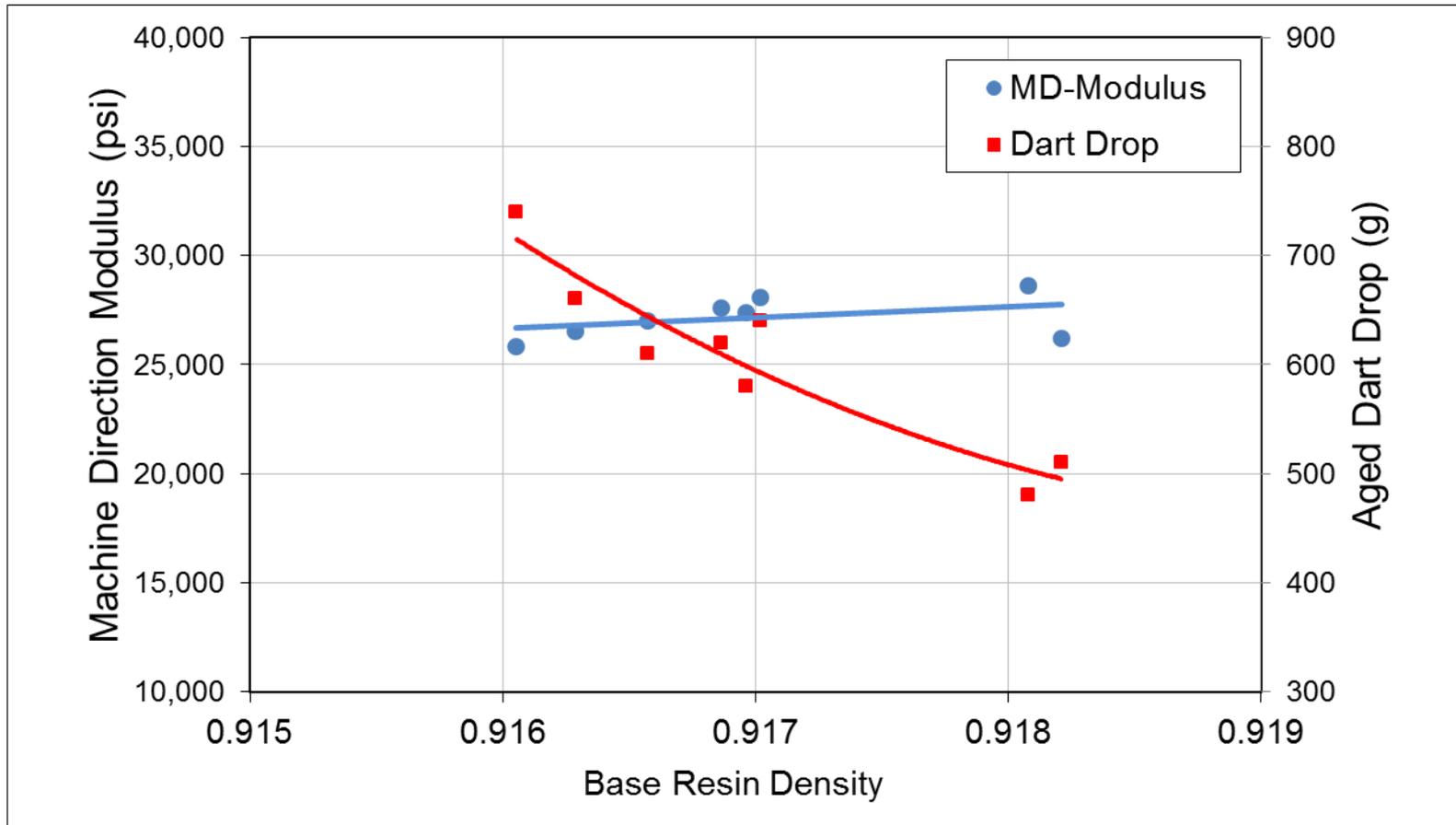
- mLLDPE and Super Hexene resins demonstrate high dart impact strength
- Blends of mLLDPE with Butene LLDPE can retain dart impact advantages



Super Hexene Density Sensitivity

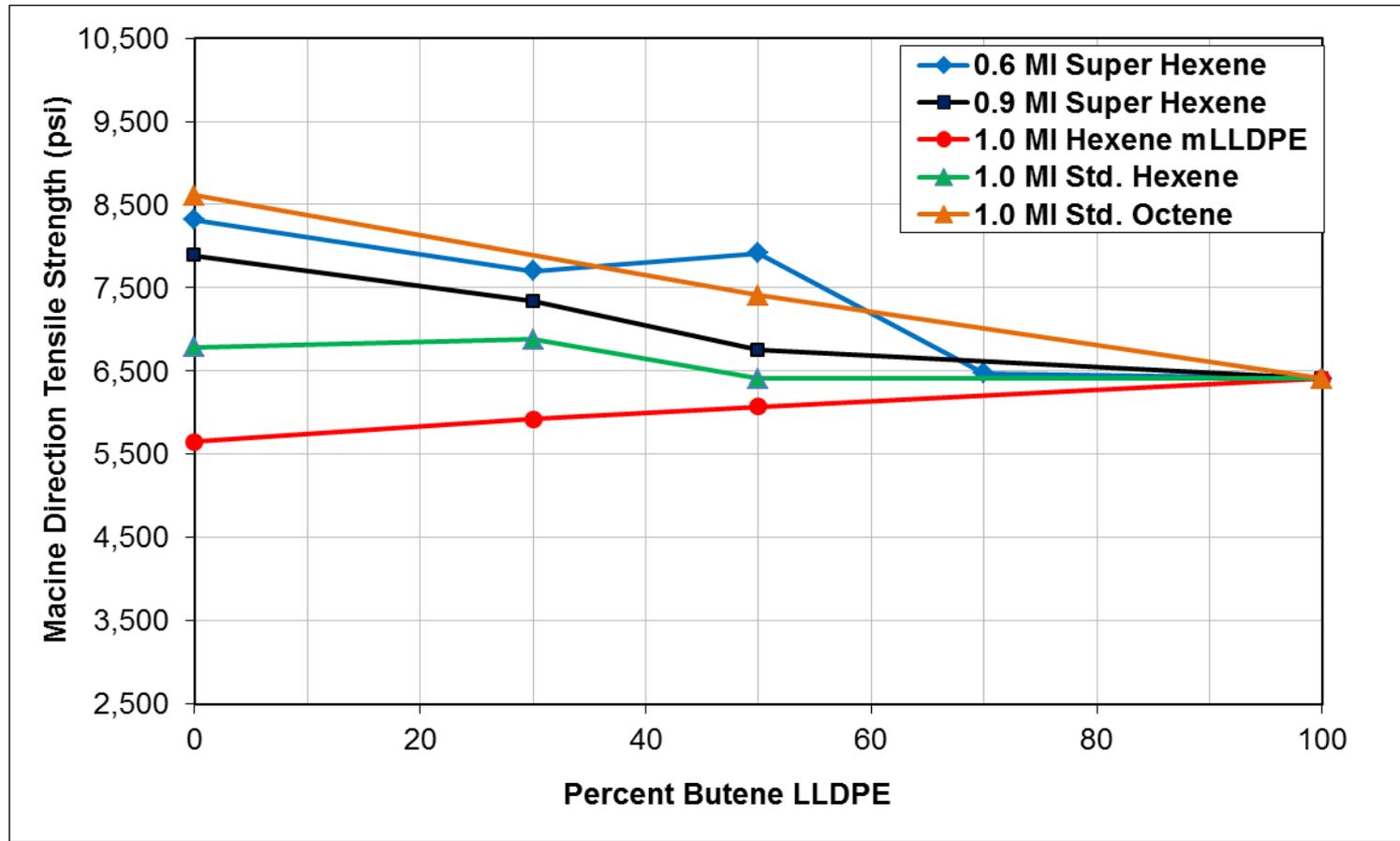
0.6 Melt Index Resin

Dart drop in Super Hexene resins is very sensitive to density while most other properties such as modulus are much less sensitive



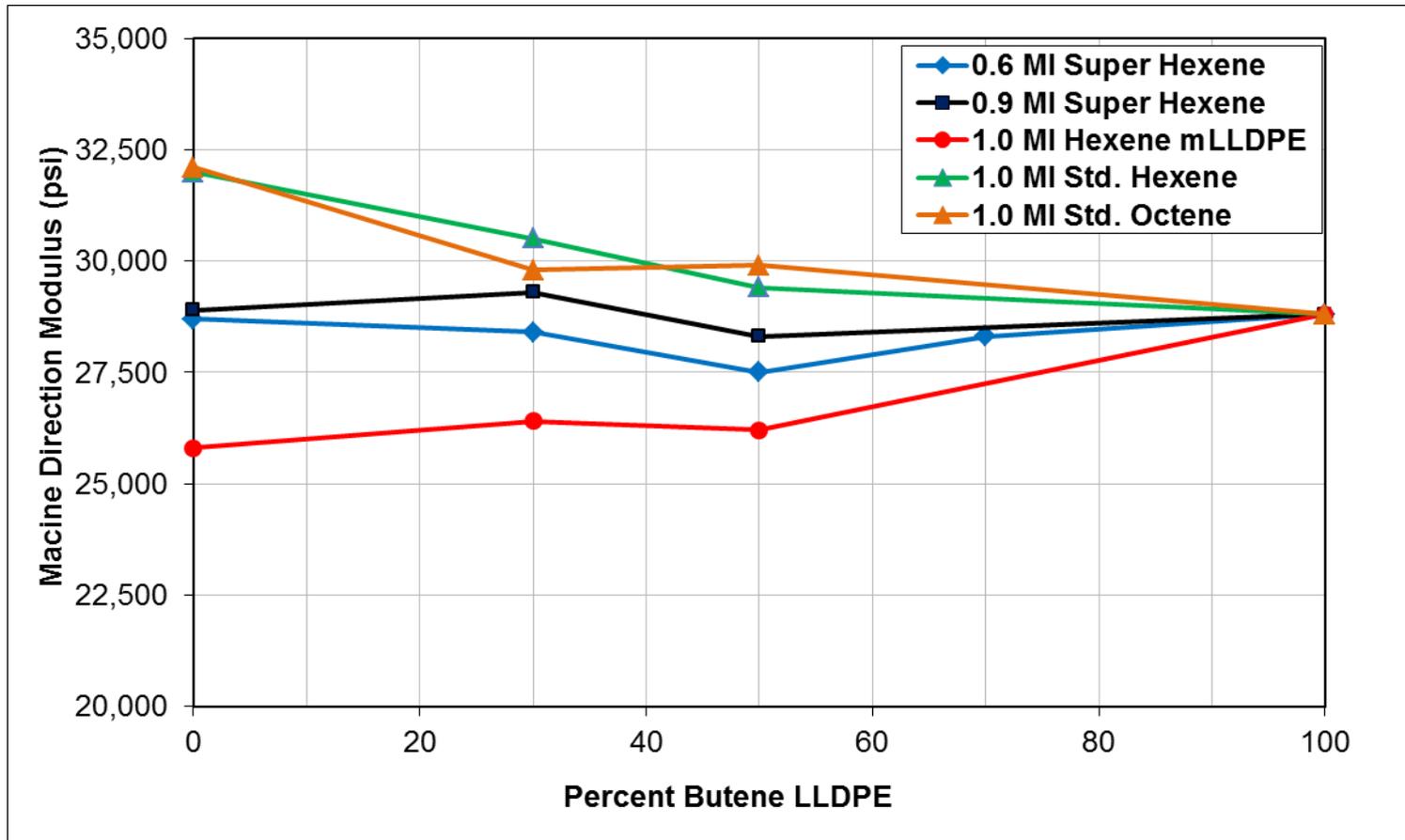
Machine Direction Tensile Strength vs. % Butene LLDPE

Standard Octene and Super Hexene resins gave the highest tensile strength



Machine Direction Modulus vs. % Butene LLDPE

Standard Octene and Hexene resins demonstrate the highest tensile modulus with mLLDPE having the lowest



Summary of Strength Properties with Standard Hexene LLDPE as the Base Line

Resin	Melt Strength	Extrudability	MD Tear (g)	Dart Drop (g)	MD Tensile Strength (psi)	MD Modulus (psi)
0.6 MI Super Hexene	++	-	++	++	+	-
0.9 MI Super Hexene	o	o	+	++	+	-
1.0 MI Hexene mLLDPE	-	--	-	+++	-	--
1.0 MI Standard Hexene	o	o	o	o	o	o
1.0 MI Standard Octene	+	+	+	+	+	o

Property Key	
+++	Highest Performing
++	
+	
o	Base Line
-	
--	Lowest Performing

Summary

- Fractional Melt Index Super Hexene Resin Offers...
 - Superior Combination of Film Strength Properties
 - Excellent Melt Strength
- In General, Films Made from Blends of Butene LLDPE with High Performance LLDPEs Show a Sharp Drop in Several Physical Properties, Even at a 30% Addition Level
- For the Butene LLDPE Containing Films,
 - High Tear Strength Can be Maintained in Some Super Hexene Based Films
 - High Dart Drop Can be Maintained in Some mLLDPE Based Films

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Questions?

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