AMI: Stretch & Shrink 2019

Cost Reduction of Shrink Films through Modification of Linear-Low-Density Polyethylene (LLDPE)

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Ingenia – who are we?

- Founded in 1986 as WedTech and renamed Ingenia Polymers Corp. in 1998.
- Four main manufacturing sites located in: Brantford (Canada), Calgary (Canada), Houston (USA) and Al-Jubail (KSA)
- Specialized in Additive Masterbatch, Superlink[®], Black and White Masterbatches, Rototuff[®], Ingenai Superblend[®] and Product Development



Comparison of LDPE vs. LLDPE for Heat Shrink Film Application

Low density polyethylene (LDPE)

- Excellent heat shrink performance
- Weak mechanical properties
- Good bubble stability
- High cost

Linear Low Density Polyethylene(LLDPE)

- Poor heat shrink performance
- Strong mechanical properties
- Poor bubble stability
- Low cost

GOAL = modify LLDPE to enhance shrink film key properties and displace costly LDPE





Processing Conditions and Material

- Monolayer blown film extrusion line is used. (Diameter:42mm L/D:26)
- All the films are produced at 2 mil thickness and BUR~ 2.
- Film extrusion temperature of 200°C.
- The screw speed is 15 rpm on a 42 mm diameter L/D:26 screw with a typical output of 30 lbs/h.
- Octene-LLDPE MI:1 and Butene-LLDPE MI:2 are used in this study.



Ingenia Polymer Modifier ITZ-349 - Effect on Shrink Properties



Heat shrink properties similar to LDPE/LLDPE blends can be obtained with addition ٠ of ITZ-349 to b-LLDPE or o-LLDPE.

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Sample Size Before Shrinking: 100mmx100mm Air Temperature: 135°C Shrinking Time: 45 seconds



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With o-LLDPE

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oll PE with 4% IL 349

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80% oll PF20% LPF

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60% OLLIPELADIOLIPE

Ingenia Polymer Modifier ITZ-349 - Effect on Shrink Properties



- The film with ITZ-349 provides similar shrink percentage at TD compare to b-LLDPE/LDPE and o-LLDPE/LDPE blends.
- The shrink percentage at TD does not follow specific trend.



Ingenia Polymer Modifier ITZ-349 - Effect on Flow Properties



- Viscosity changes at low frequency region are indication of long chain branching and/or increasing on the average weight number of molecular weight (M_w) with the addition of ITZ-349.
- o-LLDPE MI:1 and b-LLDPE MI:2 flow properties can be altered to match commercially available shrink film grades with addition of ITZ-349.

Parallel Plate Diameter: 25 mm Temperature: 190°C Frequency range: 0.1-100 rad/s



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Ingenia Polymer Modifier ITZ-349 - Effect on Impact Properties



- o-LLDPE MI:1 and b-LLDPE MI:2 can be modified with minimal reduction of impact properties.
- All measurements are done based on ASTM D1709-16a with Oakland Series 8000.



Ingenia Polymer Modifier ITZ-349 – Effect on Tensile Stress at Break Properties



- o-LLDPE MI:1 and b-LLDPE MI:2 can be modified without sacrificing tensile stress at break properties.
- Tensile tests are conducted based on ASTM D 8222 at 20inch/min at MD.



Ingenia Polymer Modifier ITZ-349 – Effect on Elongation at Break Properties



• Elongation at break is improved with modified b-LLDPE MI:2 and held similar to o-LLDPE MI:1 as compared to LDPE/LLDPE blends.

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• Tensile tests are conducted based on ASTM D 8222 at 20inch/min at MD.



Ingenia Polymer Modifier ITZ-349 – Effect on Tear Strength in MD



- Modified LLDPE provides better tear strength at MD compare to LDPE/LLDPE blends.
- Tear tests are conducted based on ASTM D 1922 with Testing Machine Instrument machine.



Ingenia Polymer Modifier ITZ-349 – Effect on Tear Strength in TD



- Tear strength at TD is improved by modifying b-LLDPE and o-LLDPE with ITZ-349, if the LDPE content is 60% and higher for LDPE/LLDPE blends
- Tear tests are conducted based on ASTM D 1922 with Testing Machine Instrument machine.



The Effect Ingenia Polymer Modifier ITZ-349 on Haze Properties



- Haze properties similar to LDPE/LLDPE blends can be obtained when ITZ-349 is used.
- Haze tests are conducted based on ASTM D 1003 with Minolta CM-3700-d machine.



Summary

Q. Is it possible to use 100% LLDPE in heat shrink film application without blending in LDPE, through addition of Ingenia's ITZ-349 Polymer Modifier?

A. All test data suggests equivalent or improved properties, with the result being total film cost savings!

Ingenia's ITZ-349 Polymer Modifier MB provides:

- Ability to tailor heat shrink properties to meet specific film application needs.
- Better tensile properties compared to LDPE/LLDPE blends.
- Better impact properties compared to LDPE/LLDPE blends.
- Comparable/better tear properties compared to LDPE/LLDPE blends.
- Comparable/improved bubble stability.



Summary

- **Removing costly LDPE** from recipe by **modifying cost efficient LLDPE** without sacrificing desired properties.
- Possibility of **down gauging** leading to savings.

Commercialization Status:

- Initial field trials on commercial equipment have been successful.
- Ingenia is ready to work with additional shrink film producers!



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