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PP solution provider helping customers be the best at what they do.

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What we do well:

Dedicated to creating niche materials that meet **specific** needs

to increase our Customers' success.

Why FHR is a Preferred Specialty Provider

- Foot Print is smaller than competitors
  - 780MM pounds of Polypropylene
  - Two separate reactors
  - More nimble than our competitors
  - Concentrate on smaller more specialized products

- Wide ranging grade slate
  - Homo-, Random, Impact Polypropylene
  - Constantly searching for the best additive and modifier technology
  - Will make customer specific solutions

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Why FHR is a Preferred Specialty Provider

- On site compounding capabilities
  - Two Compounding lines
  - Can take reactor powder and compound different additives and modifiers
  - Can go after smaller volume opportunities
  - Allows us to be competitive versus secondary compounders
- Strong support
  - Years developing knowledge and expertise to address specific needs
  - Strong Lab capabilities to make samples and do initial testing
  - Technical Support before during and after the sale
  - Very fast response to regulatory inquiries
  - In the lead with suppliers when they have something new

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New IM Material for Freezer and Cold conditions

Why Typical Random Polypropylene does not work (why are we here today?)

- More customers have a desire to see inside the packaging.
- What is the problem? Cold temperature impact, ≤4°C, of rPP containers is poor.
- What does it affect? Commercial containers needing handling and shipping after freezing. Typical storage temperature is -20°C.
- Why is it worth solving? Less loss in processing. Less loss in shipping.
- Targeting Freezer to microwave convenience. Frozen prepared foods, frozen containers for home use, ice cream, yogurt, frozen vegetables and fruits…

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Introducing FHR's new Injection Molding Grade

Suitable for Freezer and cold temperature applications

- New PP based Specialized Polyolefin
- 30MFR for thin wall applications
- Good haze characteristics with very good contact clarity
- High gloss and good color
- Suitable for Freezer and cold temperature applications
- Testing on a thin walled 1lb + container weight showed excellent results
- Tested at -20 and -30°C.

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Test Protocol

- Testing was done on a 16 oz. container that contained both ice cubes and water which was frozen.
- Frozen containers were ~25 mil thick.
- Ice cubes weight- 188.5 g. (0.42 lb.)
- Frozen water weight -566.8 g. (1.25 lb.)
- Container Weight – 19.6 g.
- Container and lid Weight – 29.5 g.
- Flat bottom drops were evaluated
- Other orientations were also tested.
- As a baseline a normal Random clarified PP was tested at 12 inches.

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Test drops (Standard Random Polypropylene)

- Standard Random Copolymer dropped from 12 inches.
- Container filled with ice cubes and put in Freezer at -20°C (188.5 g. of ice)

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Test Drop Injection Freezer Grade

- New Freezer Grade flat bottom dropped from 84 inches.
- Container filled with water and put in Freezer at -20°C (566.8 g. of ice)
- No failures at -20°C

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Outside Drop Injection Freezer Grade

- New Freezer Grade tossed in the air.
- Container filled with water and put in Freezer at -20°C (566.8 g. of ice)
- No failures at -20°C

Summary

- No failures with water or ice at -20°C test temperature.
- Product was tested at -30°C and also performed very well.
- At -30°C saw one upside drop crack at the lip at a high stress point.
- There were no flat bottom failures at -30°C.

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Physical Properties

P9H6M-069

RESIN PROPERTIES	TYPICAL VALUE (SI)	TYPICAL VALUE (ENGLISH)	ASTM TEST METHOD
Melt Flow Rate	30 g/10 min		D 1238
MECHANICAL PROPERTIES			
Tensile Yield Strength Yield Elongation	 24.1 MPa 9.5 %	 3490 psi 9.5 %	D 638
Flexural Modulus Tangent	1050 MPa	152 kpsi	D 790
Deflection Temperature @ 66 psi (.455 MPa)	79 ºC	174 ºF	D 648
Rockwell Hardness		70 R	D 785
Notched Izod @ 23ºC	NB	NB	D 256
Gardner Impact @ 23ºC @ 0ºC @ -20C	>36.2 J >36.2 J >36.2 J	>320 in-lb. >320 in-lb. >320 in-lb.	D 5420
Haze @25 mil	16.1 %	16.1 %	D1003

New BM/TF Materials for Freezer and Cold conditions

Introducing FHR's new BM Freezer Grade PP

- New PP based Specialized Polyolefin
- Designed for Blow Molding
- Good haze characteristics with very good contact clarity
- High gloss and good color
- Suitable for Freezer and cold temperature applications
- A-H FDA compliance
- Drop tested from RT to -20 C

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Freezer Grade Versions
Typical Properties

	Blow Molding P9-067 (Nuc) 23T2Acs415 (Clarified)	Thermoforming 22N2A (Nuc) 23T2Acs410 (Clarified)
Melt flow Rate	2.3 MFR	2.3 MFR
Flexural Modulus	150,000 psi	160,000 psi
Izod	NB	NB
Haze @ 25 mils	$14.5_c/17_n\%$	$13.5_c/14_n\%$
Haze @ 50 mils	$27_c/34_n\%$	$21.5_c/28_n\%$

c- clarified
n-nucleated

All Products have excellent contact clarity.

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Room Temperature Testing

- Performance of Freezer Temperature Grade (22T2Acs415 and P9-067)
  - At the Maximum test height of 84 inches there were no failures.
  - Various drop configurations and multi-drops were performed.

As expected at room temperature the new cold temperature grade performs very well with no failures @ 84 inches

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New Freezer Grade
4C Temperature Testing

- The Freezer Temperature Grade demonstrated mean failure heights of 71.2 inches for 23T2Acs415 and 84+ inches for P9-067
- failure mode for these samples was not catastrophic and predominately leaking at the bottle base just outside the weld line on the side opposite of the handle (potential design issue).

The Cold Temperature grades continues to have a high mean failure height at refrigerator conditions.

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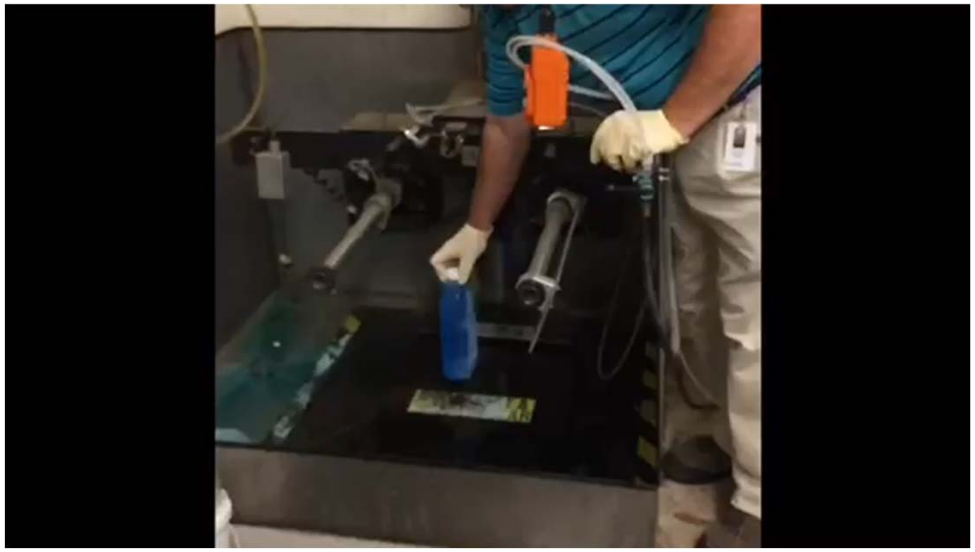
-20C (Freezer) Temperature Testing
Typical reactor random (23H2A)

- Potassium Acetate was used as a liquid which has a 1.25 SG.
- The Freezer Temperature Grade samples provided outstanding cold temperature (-20C) impact performance with mean failure heights of 58.1 and 45.5 inches for the two versions.
- The mean failure height of the commercial 23H2A RCP was less than 6 inches.



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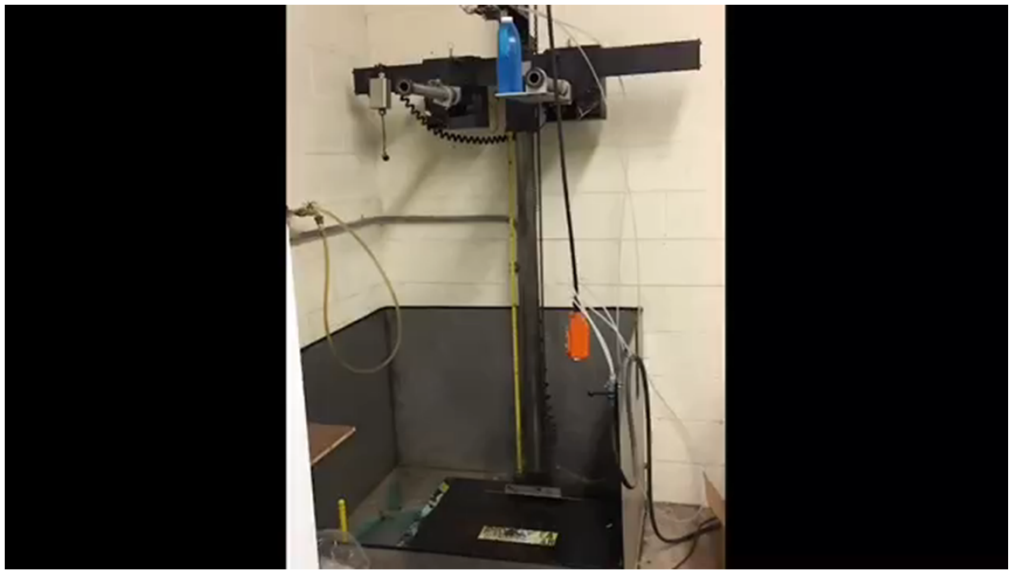
New Freezer Grade Results
-20C (Freezer) Temperature Testing (23T2Acs415)



A New freezer grade to meet the needs of the industry for cold temperatures and cold storage.

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Polypropylene Blow Molding Tips

- Injection Stretch or Blow is not suggested for PP on a HDPE tool
- EBM on shuttle or Wheel is best on a HDPE tool.
- Generally a sharp and hot knife is needed to cut the parison for PP

  If you run too cold harder to get good pinch off
- Melt strength is lower with PP
- Shrinkage is 25% lower than with HDPE
- Higher temperatures are needed (380-420°F) than for HDPE
- More Die swell with PP compared to HDPE but negated due to poor melt strength and the parison stretch

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Tips Continued:

- In order to minimize melt fracture problems, longer die land lengths have been found useful when blow molding polypropylene. A die land to die gap ratio of 10:1 is considered by many to be optimal.
- If you get melt fracture due to the short land length raising the temperature helps.
- Harder to trim. Needs to be a shear type trim and sharp and will take more force. Faster with more pressure.
- If blow pin sticking issues arise we can correct that with additives.

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New IM Material for E-Commerce Developmental

- Problem: Typical Clarified PP materials have high breakage when shipped E-commerce.
  - Too Brittle when shipping in boxes with multiple items (especially at colder Temperatures)
  - Historically improving impact sacrifices contact clarity
  - Unacceptable loss and damages related to shipping and handling products.
  - Failures lead to poor customer perception
  - Current products limit design flexibility

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Introducing FHR's new E-commerce Grade

- New PP based Specialized Polyolefin
- High MFR for thin wall applications
- Excellent haze characteristics with very good contact clarity
- High gloss and color
- Suitable for a wide variety of E-commerce applications
- A Product with clarity that matches the performance of Impact copolymers

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Product Comparison

Property	Impact Co-polymer AP5206	Typical Random	New E-Commerce 399-5	New E-commerce 399-3
MFR	6	20	30	30
Flex Modulus	230 kpsi	155 kpsi	189 kpsi	121 kpsi
Izod Impact	2.6 ft-lb/in	1.2 ft-lb/in	5.4 ft-lb/in	7.1 Ft-lb/in
Gardner 0°C	>320 in-lb.	Very low	312 in-lb.	>320 in-lb.
Haze %	70	6	12.5	5.9

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