



Plastics Forming Enterprises, LLC

Plastics Consulting, Research and Engineering

Teknopellets

Material Analysis

Objectives:

- Analyze natural pellets and mixed color pellets for pellet and part testing

Materials:

- HDPE Natural Pellets
- HDPE Mixed Color Pellets

Process:

- Material was received in pellet form at PFE
- Pellets were then tested for melt flow, density, moisture content, and ash content
- Pellets were then dried and injected molded into ASTM parts
- Parts were then tested for tensile properties, flexural modulus, and izod impact
- Data was the recorded and reported



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Natural Pellet/Part Testing Summary

<u>Test</u>	<u>Results</u>
Melt Flow Rate (g/10min)	0.511
Density (g/cc)	0.957
Moisture (%)	0.01
Ash Content (%)	0.45
Tensile Yield Strength (psi)	3327
Elongation at Break (%)	422.320
Flexural Modulus (psi)	298150
Izod Impact (break type)	Partial



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Mixed Color Pellet/Part Testing Summary

<u>Test</u>	<u>Results</u>
Melt Flow Rate (g/10min)	0.366
Density (g/cc)	0.951
Moisture (%)	0.01
Ash Content (%)	0.93
Tensile Yield Strength (psi)	3264
Elongation at Break (%)	344.976
Flexural Modulus (psi)	216894
Izod Impact (break type)	Partial

Polyolefin Melt Flow Rate

References:

ASTM D1238 B

Test Summary:

Measures the rate of extrusion of molten resins through a specified die at specified conditions

Procedure:

Ten grams of polyolefin sample is loaded into the testing equipment. Testing equipment is set to $190 \pm 0.2^\circ\text{C}$ for polyethylene and $230 \pm 0.2^\circ\text{C}$ for polypropylene. The polyolefin is softened for 7 ± 0.5 minutes in the testing equipment. The cylinder (100 grams) and weight (2060 grams) are placed in the machine. Extrudate is then manually cut at timed intervals of 60 seconds. The cut pieces are then weighed to obtain a melt flow rate (g/10min).

Data Table:

Run Number	Flow Rates (g/min)	Melt Flow Rate (g/10min)
Natural	0.513	0.511
	0.525	
	0.494	
Mixed Color	0.365	0.366
	0.364	
	0.368	

Density

References:

ASTM D792 B

Test Summary:

Determination of the specific gravity (relative density) and density of solid plastics

Conditioning:

Test specimens are conditioned at $23\pm 2^{\circ}\text{C}$ and $50\pm 5\%$ relative humidity for at least 40 hours

Procedure:

The temperature of the immersion liquid used is measured and recorded. The specimen is weighed in air to the nearest milligram. The sample is then weighed in the immersion liquid. Carefully using tweezers, the specimen is shaken to remove any excess air bubbles created upon immersing the specimen.

Data Table:

Run Number	Density g/cm ³	Average Density g/cm ³
Natural	0.959	0.957
	0.956	
	0.956	
Mixed Color	0.948	0.951
	0.953	
	0.951	

Polyolefin Moisture

References:

ASTM D6890

Test Summary:

Quantitative determination of moisture by means of loss in weight

Procedure:

For Pre-extrusion and Pre-injection,

Polyolefin material is dried in a desiccant dryer for 10-60 minutes. For the purpose to improve the quality of pellet and part production polyolefin is PFE recommended to be below 300PPM before processing. Material is removed from dryer and analyzed in moisture meter. If the material is below 300PPM the material moves forward in processing. If material is above 300PPM the material is allowed more time to dry until max time is reached.

For material moisture analysis,

Room temperature material is tested on moisture analysis equipment at specified temperatures depending on type of polyolefin (160°C for PE and 180°C for PP). Data is recorded and reported as a percentage.

Data Table:

Run Number	Avg. % Volatile
Natural	0.01
Mixed Color	0.01

Ash Content

References:

ASTM D5630 B

Test Summary:

Determine the inorganic content of plastics

Procedure:

Material is weighed into a precleaned crucible and placed in a muffle furnace at 800°C. The crucible is left in the furnace for five minutes. The material is then reweighed and the ash content % is calculated. Common causes for high ash content include minerals such as CaCO₃ and TiO₂ or glass.

Data Table:

Run Number	Ash Content %
Natural	0.45%
Mixed Color	0.93%

APR Polyolefin Injection

Test Summary:

Injection mold parts to test for mechanical properties

Procedure:

Injection material is prepped in a dryer at 80-90°C for 10-60 minutes (PFE suggest below 300 ppm). Polyolefin is injection molded at a target melt temperature of 190-245°C. The injection unit is purged between each test innovation. Melt temperature, room temperature, and mold temperature are recorded for each innovation variable.

Data Table:

Run Number	Moisture Content (ppm)	Melt Temperature (°C)	Room Temperature (°C)	Mold Temperature (°C)
Natural	91	224	32	31
Mixed Color	71	224	33	31

Standard Operating Conditions:

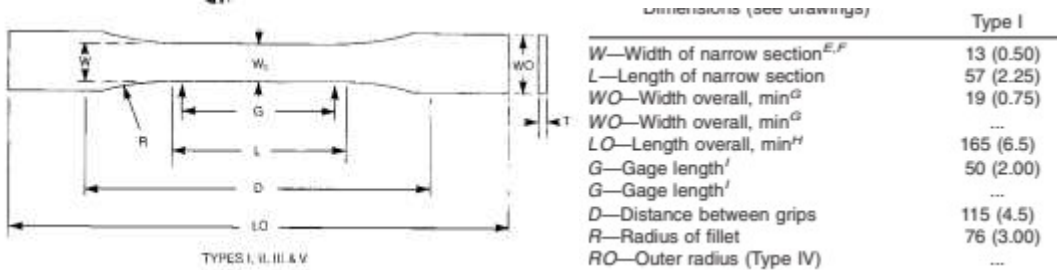
Zone 1 Temperature	Zone 2 Temperature	Zone 3 Temperature	Nozzle Temperature
210°C	215°C	220°C	225°C

Rigid Tensile Strength

References:
ASTM D638

Test Summary:
Determine the tensile strength and elongation properties of rigid plastics

Procedure:



Injection mold at least ten Type I tensile bars and test at least five. The specimens are then conditioned for at least 40 hours at 23±2°C and 50±10% relative humidity. After the conditioning, the thickness is measured across the specimen. The specimen is then firmly clamped into grips (4.5 inch separation). The extensometer is then setup at the 2-inch gage length. The specimens are then stretched at 2 or 20 inch/min depending on the density of the material (densities >0.925 are stretched at the slower rate). When the tensile bar breaks, the tensile strength and elongation at break of at least five bars are recorded.

Data Table:

Run Number	Tensile Strength at Yield (psi)	Average Tensile Strength at Yield (psi)	Elongation at Break (%)	Average Elongation at Break (%)
Natural	3366	3327	358.632	422.320
	3393		410.411	
	3384		325.531	
	3289		481.325	
	3203		535.703	
Mixed Color	3198	3264	369.815	344.976
	3207		315.520	
	3191		366.430	
	3326		336.845	
	3399		336.270	

Flexural Modulus

References:

ASTM D790 A

Test Summary:

Determine the flexural modulus properties of injection molded plastics

Procedure:

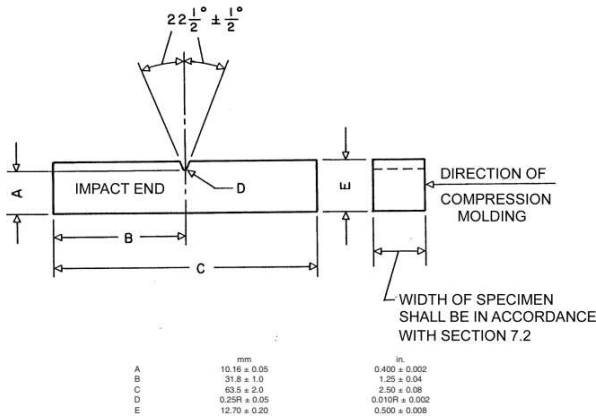
Injection mold at least five flex bars with the dimensions of 5 by 0.5 by 0.125 inches. The specimens are then conditioned for at least 40 hours at $23\pm 2^{\circ}\text{C}$ and $50\pm 10\%$ relative humidity. The specimen is then placed centered on the supports set at a two-inch span based off the bar dimensions and strain rate. The specimens are then flexed by the nose and testing is terminated when the maximum strain is reached. Upon reaching the maximum strain the flexural modulus values are recorded and reported.

Data Table:

Run Number	Flexural Modulus (psi)	Average Flexural Modulus (psi)
Natural	283546	298150
	305409	
	276067	
	305486	
	320240	
Mixed Color	214602	216894
	222563	
	211554	
	219320	
	216430	

Notched-Izod Impact Strength

References:
ASTM D256



Test Summary:

Determine the resistance of plastics to standardized machines with pendulum hammers.

Procedure:

Injection mold at least ten Izod bars with the dimensions of 2.5 by 0.5 by 0.125 inches. The specimens are then notched 0.1 inches deep with a 45-degree angle. The specimens are then conditioned for at least 40 hours at 23±2°C and 50±10% relative humidity. After the conditioning, the thickness is measured at the notch. The specimen is then firmly clamped into grips and tested. The specimens are then impacted by a pendulum with the designated weight. When the Izod bar impacted, the impact angle of at least five bars are recorded. Using a software these angles are then converted into an impact strength value.

Data Table:

Run Number	Impact Angle	Break Type
Natural	122	Partial
	122	Partial
	123	Partial
	123	Partial
	122	Partial
Mixed Color	125	Partial
	124	Partial
	126	Partial
	125	Partial
	124	Partial