Processing Guide

DuPont Engineering Polymers

Typical Processing Conditions for DuPont Engineering Polymers

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Typical Processing Conditions for DuPont Engineering Polymers

Injection Molding of Engineering Polymers

The injection molding of thermoplastic resins is a well known and widely practiced science. But it must be performed properly if the optimum properties of the material are to be achieved. DuPont Polymers makes a number of engineering plastics representing a range of chemical types. Each has its own specific processing characteristics which must be considered and understood before successful molding operations can be accomplished. The information presented is intended to provide guidance in the molding and extruding of DuPont Engineering Polymers. Additional information can be found in the Molding Guide for each product.

Processing Conditions

The optimum processing conditions for a plastic are determined by the nature of the plastic. It is important that the recommended processing conditions be followed, subject to the experience of the molder. Molding conditions can affect the performance of the polymer, especially toughness, mold shrinkage, weld lines, post mold shrinkage and surface appearance of the molded part.

Sales Information

DuPont Engineering Polymers are manufactured in ten countries and sold throughout the world. Local sales and technical support personnel are available to serve you almost anywhere. For further information, please contact any of the regional offices on the back cover.

Tables 1–5

Tables 1–5 describe typical processing conditions for injection molding of Zytel® Nylon Resin, Minlon® Engineering Thermoplastic Resin, Glass Reinforced Zytel, Delrin® Acetal Resin, Hytrel® Engineering Thermoplastic Elastomer, Rynite® PET Thermoplastic Polyester Resin, Rynite PBT Thermoplastic Polyester Resin and Zenite™.

Table 6

Table 6 describes typical extrusion conditions for Zytel, Delrin, and Hytrel.

Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 1
Zytel Nylon Resin

Resin	Resin Grade: Code	Resin Grade: Description	Dehumidifying Dryer Conditions Time/Temp.	Melt (Stock) Temperature*
66 Nylon	101 101L 101F 103HSL 103FHS 105 BK010A 122L 132F 133L	General Purpose—Unmodified General Purpose—Lubricated General Purpose—Fast Cycle Heat Stabilized—Lubricated Fast Cycle—Heat Stabilized Weather Resistant Hydrolysis Resistant Fast Cycle—Lightly Nucleated Nucleated—Color Stabilized—Lubricated	• Virgin resin is packaged dry in moisture-proof boxes and bags. Pre-drying should not be necessary unless package is damaged. • It is important to keep resin dry during molding. If residence time in the hopper is over one hour, a dehumidified hopper dryer is recommended (**80°C** [175°F]). • Regrind resin must be dried at **80°C** (175°F). Time will depend on storage time, particle size and humidity. The following are general guidelines: **Time in Open Container** / **Drying Time** (at 80°C [175°F])** 0–4 hr — 2 hr 4–24 hr — 4 hr 1–5 days — 24 hr >5 days — 48 hr Nylon will discolor on drying. The amount of color change depends on temperature and time. Consult Molding Manual on Zytel for more detailed information. **Dew point **–18°C** (<0°F)	**280–305°C** (535–580°F)
Toughened 66 Nylon	408 408HS 408L 450HSL BK 3189 3189HSL	Impact Resistant Impact Resistant—Heat Stabilized Impact Resistant—Lubricated Intermediate Impact Resistance, Heat Stabilized and Lubricated Impact Resistant Heat Stabilized—Lubricated		**290–295°C** (550–560°F)
Super Tough Nylon	ST800L ST800HSL ST801 ST801HS ST801W	Outstanding Impact Resistance—Lubricated Heat Stabilized ST800L Outstanding Impact Resistance—Lubricated Heat Stabilized ST801 Weatherable, UV Resistant ST801		**290–295°C** (550–560°F)
	ST901L ST901HSL	Amorphous Characteristics Amorphous Characteristics—Heat Stabilized		**275–300°C** (530–570°F)
	ST811HS	Super Tough Nylon 6—Heat Stabilized		**225–290°C** (440–550°F)
612 Nylon	151L 153HSL 157HSL BK010 158L	General Purpose—Lubricated Heat Stabilized—Lubricated Weather and Heat Resistant—Lubricated High Viscosity and Tougher Than 151L—Lubricated		**230–290°C** (450–550°F)
Modified Copolymer	109L	Color Stabilized—Nucleated—Lubricated		**255–290°C** (490–550°F)
Transparent Nylon	330	General Purpose—Amorphous Characteristics		**300–320°C** (570–610°F)

*The processing conditions presented here are representative of those typically used or preferred. Rounded numbers are shown for both English and SI units. See your sales representative to obtain maximum part quality on any specific job.

Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 1
Zytel Nylon Resin

Resin Grade	Reciprocating Screw Machine*							
	Typical Cylinder Temperatures				Fill Speed	Screw Speed	Back Pressure	Injection Pressure
Code	Nozzle	Front	Center	Rear				
101 101L 101F 103HSL 103FHS 105 BK010A 122L 132F 133L	**260–300°C** (500–570°F)	**270°C** (520°F)	**275°C** (525°F)	**280°C** (540°F)	Moderate to Fast	Slow to Moderate	Increasing back pressure increases the work done by the screw on the melt. This has the following advantages and disadvantages: **Advantages** • Increases melt temperature and uniformity. • Can be used to minimize unmelted particles. • Improves color mixing when color concentrates are used. **Disadvantages** • Decreases output of screw. • Increases drool (nozzle). • Reduces glass fiber length in glass-reinforced resins, thus changing physical properties (strength/impact resistance). • Increases equipment wear with filled resins. • Scrubs barrel (black specks). Screw retraction time should be approximately 80% of the cool time for optimum molding.	**34–138 MPa** (5,000–20,000 psi)
408 408HS 408L 450HSL BK 3189 3189HSL	**260–300°C** (500–570°F)	**275°C** (525°F)	**280°C** (535°F)	**295°C** (560°F)	Moderate	Slow to Moderate		**41–138 MPa** (6,000–20,000 psi)
ST800L ST800HSL ST801 ST801HS ST801W	**260–300°C** (500–570°F)	**275°C** (525°F)	**280°C** (535°F)	**295°C** (560°F)	Moderate	Slow to Moderate		**41–138 MPa** (6,000–20,000 psi)
ST901L ST901HSL	**265–305°C** (510–580°F)	**280°C** (535°F)	**285°C** (545°F)	**300°C** (570°F)	Moderate to Fast	Moderate		**69–138 MPa** (10,000–20,000 psi)
ST811HS	**225°C** (440°F)	**225°C** (440°F)	**230°C** (450°F)	**245°C** (470°F)	Moderate	Slow to Moderate		**55–138 MPa** (8,000–20,000 psi)
151L 153HSL 157HSL BK010 158L	**230°C** (450°F)	**225°C** (440°F)	**230°C** (445°F)	**240°C** (460°F)	Moderate to Fast	Slow to Moderate		**34–138 MPa** (5,000–20,000 psi)
109L	**255°C** (490°F)	**250°C** (485°F)	**255°C** (490°F)	**265°C** (505°F)	Moderate	Slow to Moderate		**41–138 MPa** (6,000–20,000 psi)
330	**275–295°C** (530–560°F)	**290°C** (550°F)	**290°C** (555°F)	**280°C** (535°F)	Moderate	Slow to Moderate		**62–138 MPa** (9,000–20,000 psi)

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 1
Zytel Nylon Resin

Resin Grade Code	Mold Surface Temperature*	Comments
101 101L 101F 103HSL 103FHS 105 BK010A 122L 132F 133L	**40–95°C** (100–200°F)	• Molding wet nylon resin will show up as one or more of these: – drool and frothy melt – splay on part surface – brittle parts • Drool can be minimized by – decreasing nozzle temperature – decreasing melt temperature – decreasing cycle – ensuring that resin is dry – using suck back, or – using a reverse taper nozzle. • If screw does not retract or retracts erratically, check rear zone temperature or heater band. Aluminum distearate may be added (20 g per **22.7 kg** [50 lb] maximum) to aid in screw retraction. Too much lubricant may show up as surface splay and/or brittle parts. Also, moisture levels greater than 0.5% may cause erratic screw recovery. Check moisture and dry to less than 0.2%. • Nylon parts will absorb moisture after molding, which can cause changes in physical properties (moisture increases impact resistance and elongation) and dimensions. • If higher toughness (impact resistance) is required, toughened compositions should be considered. • Nylon parts that have been degraded (as evidenced by brittleness or brown color) should not be reground and remolded. • Dehumidified drying ovens and vacuum drying are also suitable. • Consult the Molding Manual on Zytel for additional details.
408 408HS 408L 450HSL BK 3189 3189HSL	**40–95°C** (100–200°F)	
ST800L ST800HSL ST801 ST801HS ST801W	**40–95°C** (100–200°F)	
ST901L ST901HSL	**40–80°C** (100–175°F)	
ST811HS	**40–95°C** (100–200°F)	
151L 153HSL 157HSL BK010 158L	**40–95°C** (100–200°F)	
109L	**40–95°C** (100–200°F)	
330	**65–95°C** (150–200°F)	

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 2
Flame Retarded Nylon, Minlon Engineering Thermoplastic Resin and Glass-Reinforced Zytel

Resin Grade			Dehumidifying Dryer Conditions Time/Temp.	Melt (Stock) Temperature*
Resin	**Code**	**Description**		
Flame Retarded Nylon				
Zytel	FR10	General Purpose—Unreinforced	• Virgin resin is packaged dry in moisture-proof boxes and bags. Pre-drying should not be necessary unless package is damaged. • It is important to keep resin dry during molding. If residence time in the hopper is over one hour, a dehumidified hopper dryer is recommended (**80°C** [175°F]). • Regrind resin must be dried at **80°C** (175°F). Time will depend on storage time, particle size and humidity. The following are general guidelines: **Time in Open Container** / **Drying Time** (at 80°C [175°F])** 0–4 hr — 2 hr 4–24 hr — 4 hr 1–5 days — 24 hr >5 days — 48 hr Nylon will discolor on drying. The amount of color change depends on temperature and time. Consult Molding Manual on Zytel for more detailed information. **Dew point **–18°C** (<0°F)	**250–275°C** (480–525°F)
	FR50	25% Glass-Reinforced		**290–305°C** (550–580°F)
Minlon	FR60	Mineral-Reinforced		**295–305°C** (560–580°F)
Minlon Engineering Thermoplastic Resin				
Engineering Thermoplastic Resin	10B40	Mineral-Reinforced		**295–305°C** (560–580°F)
	10B40HS1	Mineral-Reinforced—Heat Stabilized		
	20B	Mineral/Glass-Reinforced		
	22C	Mineral/Glass-Reinforced		
	11C40	Intermediate Toughened—Mineral Reinforced		**280–300°C** (540–570°F)
	12T	Toughened—Mineral Reinforced		
GRZ Glass-Reinforced Zytel				
General Purpose	70G13L	13% Glass—Lubricated		**290–310°C** (550–590°F)
	70G13HS1L	13% Glass—Heat Stabilized, Lubricated		
	70G33L	33% Glass—Lubricated		
	70G33HRL	33% Glass—Hydrolysis Resistant, Lubricated		
	70G33HS1L	33% Glass—Heat Stabilized, Lubricated		
	70G43L	43% Glass—Lubricated		
Improved Surface	72G13L	13% Glass—Lubricated, 66/6 Copolymer		**270–285°C** (520–545°F)
	72G13HS1L	13% Glass—Heat Stabilized, Lubricated		
	72G33L	33% Glass—Lubricated, 66/6 Copolymer		
	72G33HS1L	33% Glass—Heat Stabilized, Lubricated		
	72G43L	43% Glass—Heat Stabilized, Lubricated		
Impact Modified	71G13L	13% Glass—Lubricated		**290–310°C** (550–590°F)
	71G13HS1L	13% Glass—Heat Stabilized, Lubricated		
	71G33L	33% Glass—Lubricated		
Toughened	8018	14% Glass		**290–310°C** (550–590°F)
	8018HS	14% Glass—Heat Stabilized		
	80G33L	33% Glass—Lubricated		
	80G33HS1L	33% Glass—Heat Stabilized, Lubricated		
	80G43HS1L	43% Glass—Heat Stabilized, Lubricated		
Toughened, Improved Surface	82G33L	33% Glass—Lubricated, 66/6 Copolymer		**280–305°C** (540–580°F)
GR 612 Nylon	77G33L	33% Glass—Lubricated		**280–305°C** (540–580°F)
	77G33HS1L	33% Glass—Heat Stabilized, Lubricated		
	77G43L	43% Glass—Lubricated		

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Table 2
Flame Retarded Nylon, Minlon Engineering Thermoplastic Resin and Glass-Reinforced Zytel

Resin Grade	Reciprocating Screw Machine*							
	Typical Cylinder Temperatures				Fill Speed	Screw Speed	Back Pressure	Injection Pressure
Code	Nozzle	Front	Center	Rear				
Flame Retarded Nylon								
FR10	**220–250°C** (430–480°F)	**230–240°C** (450–460°F)	**240–245°C** (460–470°F)	**245–250°C** (470–480°F)	Fast	Slow	Increasing back pressure increases the work done by the screw on the melt. This has the following advantages and disadvantages: **Advantages** • Increases melt temperature and uniformity. • Can be used to minimize unmelted particles. • Improves color mixing when color concentrates are used. **Disadvantages** • Decreases output of screw. • Increases drool (nozzle). • Reduces glass fiber length in glass-reinforced resins, thus changing physical properties (strength/impact resistance). • Increases equipment wear with filled resins. • Scrubs barrel (black specks). Screw retraction time should be approximately 80% of the cool time for optimum molding.	**34–138 MPa** (5,000–20,000 psi)
FR50	**280–295°C** (540–560°F)	**270–275°C** (520–530°F)	**275–280°C** (530–540°F)	**290–300°C** (550–570°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
FR60	**295–305°C** (560–580°F)	280–290°C (540–550°F)	**290–295°C** (550–560°F)	**295–300°C** (560–570°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
Minlon Engineering Thermoplastic Resin								
10B40 10B40HS1 20B 22C	**295–305°C** (560–580°F)	**280–290°C** (540–550°F)	**290–295°C** (550–560°F)	**295–300°C** (560–570°F)	Moderate to Fast	Slow		**55–138 MPa** (8,000–20,000 psi)
11C40 12T	**280–290°C** (540–550°F)	**275–280°C** (530–540°F)	**275–290°C** (530–550°F)	**280–295°C** (540–560°F)	Moderate to Fast	Slow		**55–138 MPa** (8,000–20,000 psi)
GRZ Glass-Reinforced Zytel								
70G13L 70G13HS1L 70G33L 70G33HRL 70G33HS1L 70G43L	**280–295°C** (540–560°F)	**270–275°C** (520–530°F)	**275–280°C** (530–540°F)	**290–300°C** (550–570°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
72G13L 72G13HS1L 72G33L 72G33HS1L 72G43L	**270–275°C** (520–530°F)	**260–265°C** (500–510°F)	**260–265°C** (500–510°F)	**270–280°C** (520–540°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
71G13L 71G13HS1L 71G33L	**280–295°C** (540–560°F)	**270–275°C** (520–530°F)	**275–280°C** (530–540°F)	**290–300°C** (550–570°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
8018 8018HS 80G33L 80G33HS1L 80G43HS1L	**275–295°C** (530–560°F)	**270–275°C** (520–530°F)	**275–280°C** (530–540°F)	**290–300°C** (550–570°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
82G33L	**280–295°C** (540–560°F)	**270–280°C** (520–540°F)	**270–280°C** (520–540°F)	**280–295°C** (540–560°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)
77G33L 77G33HS1L 77G43L	**275–295°C** (530–560°F)	**265–270°C** (510–520°F)	**270–275°C** (520–530°F)	**280–295°C** (540–560°F)	Fast	Slow		**34–138 MPa** (5,000–20,000 psi)

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 2
Flame Retarded Nylon, Minlon Engineering Thermoplastic Resin and Glass-Reinforced Zytel

Resin Grade Code	Mold Surface Temperature*	Comments
Flame Retarded Nylon		Breathing of fumes should be avoided. Consult Zytel Molding Guide for recommended molding area ventilation. • At higher temperatures and excessively long holdup time, decomposition of the flame-retarded resins may occur, evolving some hydrogen halides (which are corrosive). See MSDS for information on these resins. • Shutdown must always be preceded by completely purging the molding machine. • Glass-reinforced nylons and Minlon are abrasive to equipment. Bimetallic barrel liners and screw flight lands of a hard surfacing alloy are recommended. The following processing conditions will aid in minimizing wear: – use suggested high rear zone cylinder setting – use minimum screw speed and back pressure – keep check valve in good operating condition • The surface appearance of the molded part depends partly on the mold surface temperature. The temperatures shown here will give the best surfaces. It may be necessary to increase the nozzle temperature to prevent freeze-off. • A fast, one-second injection speed normally gives the highest gloss. • Consult the molding manual on glass-reinforced Zytel and Minlon for additional details.
FR10	**40–65°C** (100–150°F)	
FR50	**65–120°C** (150–250°F)	
FR60	**65–100°C** (150–210°F)	
Minlon Engineering Thermoplastic Resin		
10B40 10B40HS1 20B 22C	**65–100°C** (150–210°F)	
11C40 12T	**65–100°C** (150–210°F)	
GRZ Glass-Reinforced Zytel		
70G13L 70G13HS1L 70G33L 70G33HRL 70G33HS1L 70G43L	**65–120°C** (150–250°F)	
72G13L 72G13HS1L 72G33L 72G33HS1L 72G43L	**65–120°C** (150–250°F)	
71G13L 71G13HS1L 71G33L	**65–120°C** (150–250°F)	
8018 8018HS 80G33L 80G33HS1L 80G43HS1L	**65–120°C** (150–250°F)	
82G33L	**65–120°C** (150–250°F)	
77G33L 77G33HS1L 77G43L	**65–120°C** (150–250°F)	

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 3
Delrin Acetal Resin and Hytrel Engineering Thermoplastic Resin

Resin Grade			Dehumidifying Dryer Conditions Time/Temp.	Melt (Stock) Temperature**
Resin	**Code**	**Description**		
Delrin Acetal Resin*				
High Viscosity	**100** 100P 100F 100AF 107	High Viscosity Superior Processing Fast Cycle TFE Fiber Filled—Low Friction UV Stabilized (Delrin 100 Base)	Not Usually Required	**205–225°C** (400–440°F)
General Purpose	**500** 500P **500F** 500AF 500CL 507 570 577	General Purpose Superior Processing Fast Cycle TFE Fiber Filled—Low Friction Chemically Lubricated UV Stablized (Delrin 500 Base) 20% Glass—High Stiffness, Low Warpage Black Weatherable (Delrin 570 Base)		**205–225°C** (400–440°F)
Low Viscosity	**900** 900P **900F** 900HP 1700HP	Low Viscosity—High Flow Superior Processing Fast Cycle High Productivity Special Purpose High Flow		**205–225°C** (400–440°F)
Toughened	**100ST** **500T**	Super Tough (Delrin 100 Base) Toughened (Delrin 500 Base)	2–4 hr at **80°C** (175°F)	**195–215°C** (380–420°F)
Hytrel Engineering Thermoplastic Elastomer				
Most Flexible Grades and Lowest Melting	G3548W 4056	Flexible Grade with Color Stable Antioxidant Flexible Grade	Hytrel can be used directly from undamaged sealed bags and may not need to be dried prior to molding. As manufactured, these polymers are dried to a moisture content below 0.1% and packaged in special moisture-resistant bags. However, since there is a possibility of damaged or open bags, and in any case when using regrind, a desiccant hopper dryer should be used to ensure moldings of high quality. This will also protect against moisture pickup during processing. Dehumidified hopper dryers reduce and control the resin moisture content and improve quality.	**180–205°C** (355–400°F)
	HTR8122 G4074 G4078W	Most Flexible Grade Flexible Grade with High Heat Stabilizer Flexible Grade with Color Stable Antioxidant		**190–220°C** (375–430°F)
Low to Mid-Range Flexural Modulus	4069 4556 5526 5556 5555HS	Flexible Grade, High Performance Mid-Range Flexiblity With High Performance Mid-Range Flexiblity With High Performance Mid-Range Flexiblity With High Performance Mid-Range Grade with High Heat Stabilizer		**220–250°C** (430–480°F)
Mid-Range Flexibility	G4774 G5544 6356	Mid-Range Grade with High Heat Stabilizer Mid-Range Grade with High Heat Stabilizer Mid-Range with High Performance		**230–260°C** (445–500°F)
High Strength and Stiffness	7246 8238	High Modulus, High Strength, High Performance High Modulus, High Strength, High Performance		**240–260°C** (465–500°F)
Special Grades	HTR6108 HTR8068	Mid-Range with Low Permeability to Fuels and Oils Flame Retardant Grade, UL-94V-0		**205°C** (400°F)

Drying Conditions for Hytrel

	Drying Temperature	Drying Time
Dehumidified hopper	**110°C** (230°F)	2–3 hr
Dehumidified hopper	**80°C** (175°F)	overnight
Air circulating oven	**110°C** (230°F)	4–6 hr (in dry weather)

*Grades in bold type are also available in Delrin II.

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Table 3
Delrin Acetal Resin and Hytrel Engineering Thermoplastic Resin

Resin Grade	Reciprocating Screw Machine*						
	Typical Cylinder Temperatures				Fill	Screw	Back
Code	Nozzle	Front	Center	Rear	Speed	Speed	Pressure
Delrin Acetal Resin*							
100 100P 100F 100AF 107	**210°C** (410°F)	**205°C** (400°F)	**205°C** (400°F)	**205°C** (400°F)	Moderate to Fast	Slow	Increasing back pressure increases the work done by the screw on the melt. This has the following advantages and disadvantages: **Advantages** • Increases melt temperature and uniformity. • Can be used to minimize unmelted particles. • Improves color mixing when color concentrates are used. **Disadvantages** • Decreases output of screw. • Increases drool (nozzle). • Reduces glass fiber length in glass-reinforced resins, thus changing physical properties (strength/impact resistance). • Increases equipment wear with filled resins. • Scrubs barrel (black specks).
500 500P **500F** 500AF 500CL 507 570 577	**205°C** (400°F)	**200°C** (390°F)	**200°C** (390°F)	**200°C** (390°F)	Moderate to Fast	Slow to Moderate	
900 900P **900F** 900HP 1700HP	**205°C** (400°F)	**200°C** (390°F)	**200°C** (390°F)	**200°C** (390°F)	Moderate to Fast	Slow to Moderate	
100ST **500T**	**195°C** (380°F)	**190°C** (370°F)	**190°C** (370°F)	**190°C** (370°F)	Moderate to Fast	Slow to Moderate	
Hytrel Engineering Thermoplastic Elastomer							
G3548W 4056	**175°C** (345°F)	**190°C** (375°F)	**190°C** (375°F)	**165–190°C** (330–375°F)	Moderate	Moderate	Increasing back pressure increases the work done by the screw on the melt. This has the following advantages and disadvantages: **Advantages** • Increases melt temperature and uniformity. • Can be used to minimize unmelted particles. • Improves color mixing when color concentrates are used. • May be required for better mixing with any of the five Hytrel concentrates with special additives. **Disadvantages** • Decreases output of screw. • Increases drool (nozzle). • Scrubs barrel (black specks).
HTR8122 G4074 G4078W	**190°C** (375°F)	**205°C** (400°F)	**205°C** (400°F)	**180–205°C** (355–400°F)	Moderate	Moderate	
4069 4556 5526 5556 5555HS	**220°C** (430°F)	**230°C** (455°F)	**230°C** (455°F)	**205–230°C** (400–455°F)	Moderate	Moderate	
G4774 G5544 6356	**230°C** (455°F)	**245°C** (475°F)	**245°C** (475°F)	**220–245°C** (430–475°F)	Moderate	Moderate	
7246 8238	**240°C** (465°F)	**245°C** (475°F)	**245°C** (475°F)	**220–245°C** (430–475°F)	Moderate to Fast	Moderate	
HTR6108 HTR8068	**190°C** (375°F)	**205°C** (400°F)	**205°C** (400°F)	**180–205°C** (355–400°F)	Moderate	Moderate	

*Grades in bold type are also available in Delrin II.

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 3
Delrin Acetal Resin and Hytrel Engineering Thermoplastic Resin

Resin Grade Code	Injection Pressure	Mold Surface Temperature**	Comments
Delrin Acetal Resin*			
100 100P 100F 100AF 107	**69–110 MPa** (10,000–16,000 psi)	**80–105°C** (180–220°F)	**PRECAUTIONS:** Delrin has good thermal stability for normal processing, but degradation can occur under improper processing conditions, such as: • Combination of excessive hold-up times and/or high melt temperatures. • Contaminants and impurities from acid-generating resins such as PVC, flame retardant resins, etc. • Contact of the melt with copper, copper alloys or thread lubricants containing copper. Please refer to Molding Manual on Delrin for details and safety instructions. Delrin does not need to be dried usually. However, it can be dried at **85°C** (185°F) for 4 hours or less in an oven or hopper dryer, with dehumidified recirculating air systems for optimum molding. • Corrosion resistant molds recommended for Delrin AF. • Purge with clear polystyrene (only) before and after running toughened Delrin composition. The minimum purge is ten times the barrel capacity. • Improved Delrin II P resins have greater thermal stability for low mold and screw deposits.
500 500P 500F 500AF 500CL 507 570 577	**62–104 MPa** (9,000–15,000 psi)	**80–105°C** (180–220°F)	
900 900P 900F 900HP 1700HP	**48–69 MPa** (7,000–10,000 psi)	**80–105°C** (180–220°F)	
100ST 500T	**62–110 MPa** (9,000–16,000 psi)	**10–70°C** (50–160°F)	
Hytrel Engineering Thermoplastic Elastomer			
G3548W 4056	**21–100 MPa** (3,000–14,500 psi)	**25–45°C** (75–115°F)	• When handled properly, Hytrel has outstanding thermal stability. In the melt under normal operating conditions (e.g., recommended melt temperatures and <0.1% moisture content), the evolution of gaseous by-products is minimal for most grades. • Regrind can be used up to a level of 25% or more, without a significant drop in mechanical properties, providing the quality of the regrind is good. This can be checked with measurements of Melt Flow Rate relative to a control of resin out of the bag. Further details can be found in the "Rheology and Handling Guide" for Hytrel. All regrind must be dried before processing. • General-purpose screws with a gradual transition zone are recommended. Screw compression ratio should be between 2.5 and 3.5 to 1. • Since Hytrel is relatively soft and flexible, some difficulties in part ejection may be experienced with the very soft grades less than 45D. Large knockout pins may be used and ample draft on cores. To reduce possible sticking problems, a matted surface finish on molds is preferred with the softer grades. • Consult the "Injection Molding Guide" for Hytrel for additional details.
HTR8122 G4074 G4078W	**21–100 MPa** (3,000–14,500 psi)	**25–45°C** (75–115°F)	
4069 4556 5526 5556 5555HS	**34–138 MPa** (5,000–20,000 psi)	**25–75°C** (75–165°F)	
G4774 G5544 6356	**34–141 MPa** (5,000–19,000 psi)	**25–75°C** (75–165°F)	
7246 8238	**62–138 MPa** (9,000–20,000 psi)	**25–75°C** (75–165°F)	
HTR6108 HTR8068	**21–100 MPa** (3,000–14,500 psi)	**25–45°C** (75–115°F)	

*Grades in bold type are also available in Delrin II.

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 4
Rynite PET and Rynite PBT Thermoplastic Polyester Resin

Resin	Resin Grade		Dehumidifying Dryer Conditions Time/Temp.	Melt (Stock) Temperature*
	Code	Description		
Rynite PET Thermoplastic Polyester Resin				
General Purpose	530 545 555	30% Glass-Reinforced 45% Glass-Reinforced 55% Glass-Reinforced, Highest Stiffness	**Hopper Dryer Required** Air Temperature: **120–135°C** (250–275°F) **105°C** (225°F) overnight Dew Point: **–18°C** (0°F) or lower Air Flow Rate: 0.8–1.0 CFM per lb/hr of resin processed Drying Time: Virgin resin 2–3 hr Recycled regrind 3–4 hr Wet resin (See Drying Manual)	**280–300°C** (540–570°F)
	408	30% Glass-Reinforced, Improved Toughness		**270–290°C** (520–550°F)
Low Warp	935 940	35% Mica/Glass-Reinforced 40% Mica/Glass-Reinforced		**280–300°C** (540–570°F)
Flame Retarded	FR515 FR530 FR543 FR943 FR945 FR946	Flame Retarded—15% Glass-Reinforced Flame Retarded—30% Glass-Reinforced Flame Retarded—43% Glass-Reinforced Flame Retarded—43% Glass/Glass Flake Flame Retarded—45% Glass/Mineral Flame Retarded—46% Glass/Glass Flake		**270–290°C** (520–550°F)
Super Toughened	SST35	Stiffened, Super Tough, 35% Glass-Reinforced		**270–290°C** (520–550°F)
Toughened	415HP	Toughened, 15% Glass-Reinforced		**270–290°C** (520–550°F)
Rynite PBT Thermoplastic Polyester Resin				
Unreinforced	6125	Heat Stabilized		**250–260°C** (480–500°F)
Toughened	6400	Super Tough		**250–260°C** (480–500°F)
Flame Retardant	FR6944	Flame Retarded—UL94 V-0		**250–260°C** (480–500°F)
Glass Reinforced	7015 7030	15% Glass Reinforced 30% Glass Reinforced		**250–260°C** (480–500°F)
Glass Reinforced, Flame Retardant	FR7915 FR7930 FR7930F	15% Glass Reinforced, Flame Retardant 30% Glass Reinforced, Flame Retardant 30% Glass Reinforced, High Flow, Flame Retardant		**250–260°C** (480–500°F)

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 4
Rynite PET and Rynite PBT Thermoplastic Polyester Resin

Resin Grade	Reciprocating Screw Machine*				
	Typical Cylinder Temperatures				
Code	Nozzle	Front	Center	Rear	Fill Speed
Rynite PET Thermoplastic Polyester Resin					
530 545 555	**275–300°C** (530–570°F)	**265–295°C** (510–560°F)	**260–295°C** (500–560°F)	**260–290°C** (500–550°F)	Moderate to Fast
408	**260–295°C** (500–560°F)	**260–280°C** (500–540°F)	**260–280°C** (500–540°F)	**260–275°C** (500–530°F)	Moderate to Fast
935 940	**275–300°C** (530–570°F)	**265–295°C** (510–560°F)	**260–295°C** (500–560°F)	**260–290°C** (500–550°F)	Moderate to Fast
FR515 FR530 FR543 FR943 FR945 FR946	**260–295°C** (500–560°F)	**260–280°C** (500–540°F)	**260–280°C** (500–540°F)	**260–275°C** (500–530°F)	Moderate to Fast
SST35	**260–295°C** (500–560°F)	**260–280°C** (500–540°F)	**260–280°C** (500–540°F)	**260–275°C** (500–530°F)	Moderate to Fast
415HP	**260–295°C** (500–560°F)	**260–280°C** (500–540°F)	**260–280°C** (500–540°F)	**260–275°C** (500–530°F)	Moderate to Fast
Rynite PBT Thermoplastic Polyester Resin					
6125	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**230–250°C** (450–480°F)	Moderate to Fast
6400	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**230–250°C** (450–480°F)	Moderate to Fast
FR6944	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**230–250°C** (450–480°F)	Moderate to Fast
7015 7030	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**230–250°C** (450–480°F)	Moderate to Fast
FR7915 FR7930 FR7930F	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**240–260°C** (460–500°F)	**230–250°C** (450–480°F)	Moderate to Fast

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 4
Rynite PET and Rynite PBT Thermoplastic Polyester Resin

Resin Grade	Reciprocating Screw Machine*		
Code	Screw Speed	Back Pressure	Injection Pressure
Rynite PET Thermoplastic Polyester Resin			
530 545 555	Slow	Increasing back pressure increases the work done by the screw on the melt. This has the following advantages and disadvantages: **Advantages** • Increases melt temperature and uniformity. • Can be used to minimize unmelted particles. • Improves color mixing when color concentrates are used. **Disadvantages** • Decreases output of screw. • Increases drool (nozzle). • Reduces glass fiber length in glass-reinforced resins, thus changing physical properties (strength/impact resistance). • Increases equipment wear with filled resins. • Scrubs barrel (black specks). Screw retraction time should be approximately 80% of the cool time for optimum molding.	**34–124 MPa** (5,000–18,000 psi)
408	Slow		**34–124 MPa** (5,000–18,000 psi)
935 940	Slow		**34–124 MPa** (5,000–18,000 psi)
FR515 FR530 FR543 FR943 FR945 FR946	Slow		**34–124 MPa** (5,000–18,000 psi)
SST35	Slow		**55–124 MPa** (8,000–18,000 psi)
415HP	Slow		**55–124 MPa** (8,000–18,000 psi)
Rynite PBT Thermoplastic Polyester Resin			
6125	Slow		**55–95 MPa** (8,000–14,000 psi)
6400	Slow		**69–124 MPa** (10,000–18,000 psi)
FR6944	Slow		**55–95 MPa** (8,000–14,000 psi)
7015 7030	Slow		**55–95 MPa** (8,000–14,000 psi)
FR7915 FR7930 FR7930F	Slow		**55–95 MPa** (8,000–14,000 psi)

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 4
Rynite PET and Rynite PBT Thermoplastic Polyester Resin

Resin Grade Code	Mold Surface Temperature*	Comments
Rynite PET Thermoplastic Polyester Resin		
530 545 555	**Part Thickness** / **Minimum Temperature** **0.75 mm** (0.03 in) — **110°C** (230°F)	• Proper drying of polyesters is critical, to prevent resin degradation. Moisture content must be less than 0.02% for PET, less than 0.04% for PBT. If degradation should occur because of excessive moisture, there will be no evidence on the surfaces of parts—they will just be brittle. • High surface gloss can be obtained if the mold surface temperature is **93°C** (200°F) or hotter. This hot mold will also give optimum long-term dimensional stability. • To reduce wear, bimetallic barrel liners and screw flight lands of a hard surfacing alloy are recommended. • Consult molding guide on Rynite for additional details. • Screw compression ratios are a compromise between melt temperature uniformity and glass fiber length. A range of 3.0–3.5 has been found to be best.
408	**1.5 mm** (0.06 in) — **105°C** (220°F) **3.1 mm** (0.12 in) — **100°C** (210°F)	
935 940	**6.3 mm** (0.25 in) — **90°C** (190°F)	
FR515 FR530 FR543 FR943 FR945 FR946		
SST35 415HP	**Part Thickness** / **Minimum Temperature** **0.75 mm** (0.03 in) — **95°C** (205°F) **1.5 mm** (0.06 in) — **90°C** (195°F) **3.1 mm** (0.12 in) — **85°C** (185°F) **6.3 mm** (0.25 in) — **75°C** (165°F)	
Rynite PBT Thermoplastic Polyester Resin		
6125	**30–65°C** (90–150°F)	
6400	**30–65°C** (90–150°F)	
FR6944	**30–65°C** (90–150°F)	
7015 7030	**30–65°C** (90–150°F)	
FR7915 FR7930 FR7930F	**30–65°C** (90–150°F)	

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 5
DuPont Liquid Crystal Polymer

Resin	Resin Grade		Dehumidifying Dryer Conditions Time/Temp.	Melt Temperature*
	Code	Description		
General Purpose Amorphous	HX1000 HX1130 HX1330	Neat Resin 30% Glass 30% Talc	**Hopper Dryer Required** Air Temperature: **120–150°C** (250–300°F) Dew Point: **–18°C** (0°F) or lower Air Flow Rate: 0.8–1.0 CFM per lb/hr of resin processed Drying Time: Virgin resin 2–3 hr Recycled regrind 3–4 hr	**330–340°C** (625–645°F)
High Temperature Crystalline	HX4000 HX4100 HX4200 HX4330	Neat Resin 30% Glass 50% Glass 30% Talc		**340–355°C** (640–670°F)
High Toughness Crystalline	HX6000 HX6130 HX6150 HX6330	Neat Resin 30% Glass 50% Glass 30% Talc		**345–360°C** (650–680°F)
Tough/High Temperature Crystalline	HX7000 HX7130 HX7150 HX7330	Neat Resin 30% Glass 50% Glass 30% Talc		**355–380°C** (670–720°F)

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 5
DuPont Liquid Crystal Polymer

Resin Grade	Reciprocating Screw Machine*						
	Typical Cylinder Temperatures				Fill Speed	Screw Speed	Back Pressure
Code	Nozzle	Front	Center	Rear			
HX1000 HX1130 HX1330	**340°C** (640°F)	**335°C** (635°F)	**330°C** (630°F)	**325°C** (620°F)	Very Fast (<1 sec)	Slow (<0.4 m/sec [16 in/sec])	Low **0–0.69 MPa** (0–100 psi) Increasing back pressure increases the work done by the screw on the melt. This has the following advantages and disadvantages: **Advantages** • Increases melt temperature and uniformity. • Minimizes unmelted particles. • Improves color mixing when color concentrates are used. **Disadvantages** • Decreases output of screw. • Increases drool (nozzle). • Reduces glass fiber length in glass-reinforced resins, thus changing physical properties. • Increases equipment wear with filled resins. • Scrubs barrel (black specks).
HX4000 HX4100 HX4200 HX4330	**340°C** (645°F)	**340°C** (640°F)	**335°C** (635°F)	**330°C** (625°F)	Very Fast (<1 sec)	Slow (<0.4 m/sec [16 in/sec])	
HX6000 HX6130 HX6150 HX6330	**345°C** (650°F)	**340°C** (645°F)	**340°C** (640°F)	**335°C** (635°F)	Very Fast (<1 sec)	Slow (<0.4 m/sec [16 in/sec])	
HX7000 HX7130 HX7150 HX7330	**355°C** (670°F)	**350°C** (665°F)	**345°C** (655°F)	**345°C** (655°F)	Very Fast (<1 sec)	Slow (<0.4 m/sec [16 in/sec])	

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Typical Injection Molding Conditions for Zytel, Minlon, GRZ, Flame Retarded Nylons, Delrin, Hytrel, Rynite, and Zenite

Table 5
DuPont Liquid Crystal Polymer

Resin Grade Code	Reciprocating Screw Machine*			Comments
	Pressure Injection	Holding (Packing) Pressure	Mold Surface Temperature*	
HX1000 HX1130 HX1330	**40–125 MPa** (6,000–18,000 psi)	**30–100 MPa** (4,500–14,500 psi)	**80–120°C** (180–250°F)	• Drying is critical, to prevent resin degradation. Moisture content must be less than 0.010%. If degradation should occur because of excessive moisture, there will be no evidence on the surfaces of parts. • Being a shear-sensitive resin, high fill rates are required to obtain a low melt viscosity for easy filling of long thin wall sections. This also contributes to the anisotropic properties—including high physical properties, low thermal expansion and low mold shrinkage in the flow direction. • Gate locations should be chosen to avoid weld lines in critical areas. Multiple gates are generally not recommended. • Zenite has excellent thermal stability. In order to minimize any possible effect of glass breakage, it is recommended that regrind be limited initially to 25%. • It is not necessary to purge with another resin if Zenite is to be molded upon reheating. When switching to or from another resin, purge with low melt index high-density polyethylene. This should be a continuous purging whenever barrel temperatures exceed **315°C** (600°F). • General purpose screws are recommended to reduce glass fiber breakage. To reduce wear, bimetallic barrel liners and screw flight lands of a hard surfacing alloy are recommended.
HX4000 HX4100 HX4200 HX4330	**30–125 MPa** (4,500–18,000 psi)	**30–100 MPa** (4,500–14,500 psi)	**80–120°C** (180–250°F)	
HX6000 HX6130 HX6150 HX6330	**30–125 MPa** (4,500–18,000 psi)	**30–100 MPa** (4,500–14,500 psi)	**80–120°C** (180–250°F)	
HX7000 HX7130 HX7150 HX7330	**30–125 MPa** (4,500–18,000 psi)	**30–100 MPa** (4,500–14,500 psi)	**80–120°C** (180–250°F)	

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Typical Extrusion Conditions for Zytel, Delrin, and Hytrel

Table 6
Zytel, Delrin, Hytrel

Resin	Resin Grade		Dehumidifying Dryer Conditions Time/Temp.
	Code	Description	
Zytel Nylon Resin			
66 Nylon	42 45HSB	High Viscosity Heat Stabilized 42—Lubricated	Zytel must be dry prior to processing. • Virgin resin is packaged dry in moisture-proof boxes and bags. Predrying may not be necessary in noncritical applications. • Drying in dehumidified hopper driers is recommended (**80°C** [175°F] for 2 hr). Regrind or material from opened bags will require longer times. • Consult the Zytel Molding Manual for more detailed information.
612 Nylon	153HSL 158L 159L	Heat Stabilized—Lubricated General Purpose High Viscosity	
	350PHS 351PHS	Super Tough—Plasticized—Heat Stabilized Highly Plasticized—Heat Stabilized	
6 Nylon	ST811HS	Flexible—Heat Stabilized	
Modified Copolymers	91AHS	Heat Stabilized—Lubricated	
Delrin Acetal Resin			
High Viscosity	II150SA 100ST	High Viscosity Toughened	Delrin does not usually require drying before processing. However, Delrin 100ST must be dried (2–4 hr at **80°C** [175°F]).
General Purpose	II550SA	General Purpose	
Hytrel Engineering Thermoplastic Elastomer			
Most Flexible Grades and Lowest Melting	G3548W 4056	Flexible Grade with Color Stable Antioxidant Flexible Grade	Hytrel must be dry prior to extrusion. • Virgin resin is packaged in moisture-proof bags. To ensure dryness, resin should be dried in dehumidifying driers a minimum of 2 hr at **105°C** (220°F). • Consult "Rheology and Handling" bulletin on Hytrel for more information.
	HTR8122 G4074 G4078W	Most Flexible Grade Flexible Grade with High Heat Stabilizer Flexible Grade with Color Stable Antioxidant	
Low to Mid-Range Flexural Modulus	4069 4556	Flexible Grade, High Performance Mid-Range Flexibility with High Performance	
	5556 5555HS	Mid-Range Flexibility with High Performance Mid-Range Grade with High Heat Stabilizer	
Mid-Range Flexibility	G4774 G5544 6356	Mid-Range Grade with High Heat Stabilizer Mid-Range Grade with High Heat Stabilizer Mid-Range with High Performance	
High Strength and Stiffness	7246 8238	High Modulus, High Strength and Performance High Modulus, High Strength and Performance	
Special Grades	HTR6108	Mid-Range with Low Permeability to Fuels and Oils	
	HTR8139LV	Mid-Range Flexibility with Excellent Flex Fatigue Resistance	
High Viscosity Grades	HTR5612 HTR5612 BK HTR4275 HTR4275 BK	Mid-Range Grade with High Heat Stabilizer Mid-Range Grade with High Heat Stabilizer Mid-Range Grade with High Heat Stabilizer Mid-Range Grade with High Heat Stabilizer	
	HTR8177	High Modulus, High Strength	

*The processing conditions presented here are representative of those typically used or preferred. Rounded numbers are shown for both English and SI units. See your sales representative to obtain maximum part quality on any specific job.

Typical Extrusion Conditions for Zytel, Delrin, and Hytrel

Table 6
Zytel, Delrin, Hytrel

Typical Extruder Temperatures*							Comments
Rear	Center Rear	Center Front	Front	Head	Die	Melt	
Zytel Nylon Resin							
290°C (550°F)	**280°C** (540°F)	**280°C** (540°F)	**275°C** (530°F)	**275°C** (530°F)	**275°C** (530°F)	**290°C** (550°F)	Zytel, Hytrel and Delrin tubing may be sized using common commercial methods employed with other resins. • An extruder with an L/D ratio of at least 24/1 is recommended. • It is recommended that the barrel be equipped with at least four heat control zones. • Do not use undercut feed throats. • Properly designed single-stage metering screws are adequate. For high output a barrier screw is preferred. • A breaker plate of streamlined design is suggested for supporting a screen pack of two 60 mesh and two 80 mesh screens. • The extruder head and adaptor must be streamlined. • The die and mandrel design for a vacuum sizing process should have: 1. A ratio of die I.D./sizing plate I.D. of at least 2/1 for small diameter tubing. 2. The annulus opening should be approximately twice the tube wall thickness. 3. A minimum straight land length of 35 mm is recommended for both the mandrel and die at the exit. Use a drawdown ratio of 4/1 to 10/1 for free extrusion. (The drawdown ratio is the cross sectional area of the die annulus divided by the cross sectional area of the tube.)
240°C (460°F)	**240°C** (460°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	
230°C (450°F)	**225°C** (440°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	
240°C (460°F)	**240°C** (460°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	
240°C (460°F)	**240°C** (460°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	**230°C** (450°F)	
Delrin Acetal Resin							
205°C (400°F)	**205°C** (400°F)	**200°C** (390°F)	**200°C** (390°F)	**200°C** (390°F)	**205°C** (400°F)	**210°C** (410°F)	
Hytrel Engineering Thermoplastic Elastomer							
180°C (355°F)	**180°C** (355°F)	**180°C** (355°F)	**180°C** (355°F)	**180°C** (355°F)	**180°C** (355°F)	**180°C** (355°F)	
195°C (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	
220°C (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	
225°C (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	
230°C (445°F)	**230°C** (445°F)	**230°C** (445°F)	**230°C** (445°F)	**230°C** (445°F)	**230°C** (445°F)	**230°C** (445°F)	
240°C (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	
195°C (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	**195°C** (385°F)	
220°C (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	**220°C** (430°F)	
225°C (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	**225°C** (435°F)	
240°C (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	**240°C** (465°F)	

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MIDWEST

DuPont Engineering Polymers
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DuPont Engineering Polymers
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WEST

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Canada

DuPont Canada, Inc.
DuPont Engineering Polymers
P.O. Box 2200
Streetsville, Mississauga
Ontario, Canada L5M 2H3
(905) 821-5953

Europe

DuPont de Nemours Int'l S.A.
2, chemin du Pavillon
P.O. Box 50
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
Telephone: ##41 22 7175111
Telefax: ##41 22 7175200

Asia Pacific

DuPont Asia Pacific Ltd.
P.O. Box TST 98851
Tsim Sha Tsui
Kowloon, Hong Kong
852-3-734-5345

Latin America

DuPont S.A. de C.V.
Homero 206
Col. Chapultepec Morales
11570 Mexico D.F.
(011 525) 250-8000

Japan

DuPont Kabushiki Kaisha
Arco Tower
8-1, Shimomeguro 1-chome
Meguro-ku, Tokyo 153
Japan
(011) 81-3-5434-6100

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