DuPont™ Elvax®

INJECTION MOLDING GUIDE

DuPont™ Elvax® resins are copolymers of ethylene and vinyl acetate ranging in vinyl acetate content from 9 to 40% and in melt index from 0.3 to 500 dg/min. They are inherently tough, resilient and more flexible than low density polyethylene over a broad temperature range, and have excellent environmental stress crack resistance. Clarity varies from translucent to transparent.

With no plasticizer to migrate and low odor, these resins offer advantages for use in many applications now served by plasticized polyvinyl chloride and compounded rubbers. Typical applications include flexible hose and tubing, automobile bumper systems, footwear components, wire and cable compounding, molded automotive parts, toys and athletic goods. F.D.A. regulation 177.1350 allows the use of Elvax® resins as articles or components of articles for use in contact with food, subject to the extraction limits referred to in the regulation.

This bulletin presents detailed information on equipment, operating conditions and procedures for injection molding Elvax® resins. These resins can also be processed by other conventional thermoplastic methods including structural foam molding, sheet and shape extrusion, blow molding and wire coating. Conventional rubber processing techniques such as Banbury, two-roll milling and compression molding may also be used.

RESIN HANDLING

Elvax® resins are supplied in 500 kg (1,102 lb) boxes or 25 kg (55.1 lb) bags. Selected products are available in bulk hopper cars or hopper trucks. These resins are not hygroscopic and may be used as received without need for drying. If the resin should become wet in storage, it can be dried in a dehumidifying, circulating air oven. Resins containing less than 33% vinyl acetate may be dried at 60ºC (140ºF); resins containing 33% or more vinyl acetate should be dried at 50ºC (120ºF). With dryer trays filled to a depth of 1 inch, eight hours of drying time should be adequate. If oven temperature is known to fluctuate more than a few degrees, the set temperatures should be reduced accordingly to avoid caking of the resin in the trays.

Condensation of moisture on the resin in cold weather can be avoided by keeping about a one-shift supply of resin in the operating area. This allows the resin to warm above the condensation temperature before the container is opened.

Normal resin handling techniques such as pneumatic hopper loaders are used with DuPont™ Elvax® resins, but long distance pneumatic transport systems need to be carefully designed for these resins because of their low hardness and low softening temperature.

SAFETY

As with any hot material, care should be taken to protect the hands and other exposed parts of the body when handling molten polymer. At temperatures above 220ºC (425ºF), Elvax® resins can evolve fumes. Proper ventilation should be provided to insure that people do not breathe the fumes. Spilled resin should be swept up promptly since pellets present a slipping hazard. More detailed information on safe handling and disposal of Elvax® resins is provided in a Material Safety Data Sheet available from DuPont. Visit **www.dupont.com**. or call DuPont toll-free (U.S.) 800-441-7515. If calling from outside the U.S., call 302-774-1000.

PROCESSING TEMPERATURES

Heating Cylinder

Machine hopper throat must be kept cool to prevent caking and bridging. Water cooling of the hopper throat is recommended, although setting the rear zone of the heating cylinder at 120ºC (250ºF) or below is often sufficient.

Because the feed throat of the cylinder must be kept cool in both ram and screw type machines, a rising temperature profile from rear to front of the cylinder is generally used. This is subject, of course, to the requirements of the cycle and the size of the shot compared to the capacity of the machine. Fast cycles and large shot size may require a more even profile, or in some cases a rear zone setting above that of the front zone. Table 1 lists recommended cylinder temperatures for the average molding job. These will need to be modified to suit specific molding requirements. Thin-section, long-flow moldings may require higher melt or mold temperatures, while thicker moldings may need lower melt temperature for easier ejection and shorter cycles.

Table 1 – Suggested Startup Conditions for Elvax® Resins

Cylinder Temperature, ºC (ºF)	
Rear	120 (250)[1]
Center	150 (300)
Front	175 (350)
Nozzle	150-200 (300-400)
Maximum Melt Temperature, ºC (ºF)	220 (425)
Screw Back Pressure	0
Mold Temperature, ºC (ºF)	10 (50)[2]
Cycle, seconds	
Injection	15[3]
Booster	0-5
Cure	(4)
Injection Pressure	Maximum without flash[5]
Fill Rate	Slow

(1) Raise temperature at this location for parts or cycles taxing plasticating capacity of machine.

(2) Raise to improve flow and surface finish. Lower for fast cycle, lower shrinkage, good ejection.

(3) Varies with part thickness; reduce injection time as possible. Follow by reducing cure.

(4) Approximately 90 seconds per 6.35 mm (0.250 in) of thickness.

(5) Adjust to fill cavity. Second stage pressure may be lower for holding.

Mold

Mold coolant temperatures between 5ºC and 50ºC (40ºF and 120ºF) have been used, with 15-40ºC (60-100ºF) being more common. Above 40ºC (100ºF), indentation or distortion of the molding often results. Coolant temperatures below about 15ºC (60ºF) may cause flow patterns on the surface of the molding.

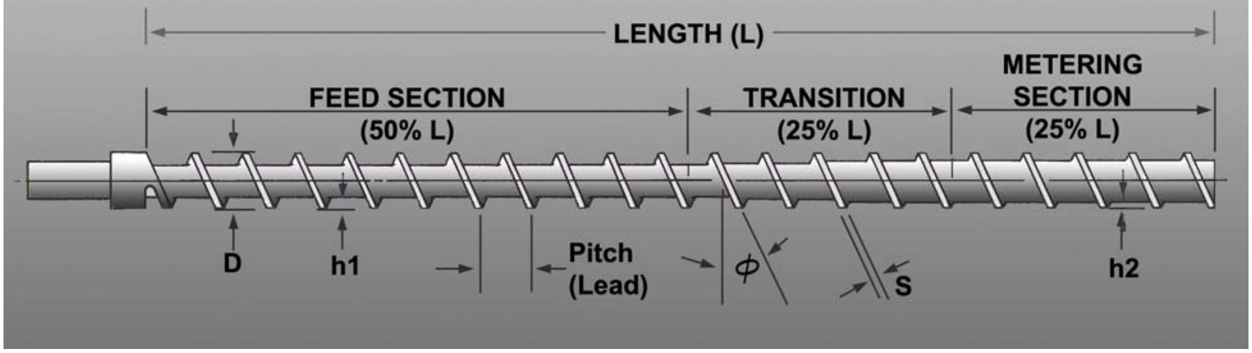
PROCESSING EQUIPMENT

Elvax® resins have been molded in all standard screw and ram type injection molding machines. Experience has shown screws normally used for injection molding of low density polyethylene to be satisfactory. Shallow metering zone screws may cause excessive working of the resin, making melt temperature control more difficult, especially at high output rates. Table 2 shows suggested screw dimensions for processing DuPont™ Elvax® resins.

Table 2 – Suggested Screw Dimensions for Processing Elvax® Resins

Screw Diameter, mm (in.) (ref. Figure 1, dimension "D")	**Flight, mm (in.)** (ref. Figure 1, dimension "h1")	**Depth, mm (in.)** (ref. Figure 1, dimension "h2")
38 (1.5)	7.6 (0.300)	2.2 (0.085)
50 (2.0)	8.4 (0.330)	2.4 (0.095)
64 (2.5)	8.8 (0.350)	2.7 (0.105)
76 (3.5)	9.5 (0.400)	2.9 (0.130)
90 (4.5)	10.0 (0.450)	3.3 (0.150)

Figure 1 — Metering Type Screw Design



PURGING

Because of the relatively low melt temperature used for molding DuPont™ Elvax® resins, and their softness, purging higher melting resins from the heating cylinder is usually more speedily accomplished using a harder resin with a broad molding temperature range, such as high density polyethylene.

MOLDING PROCEDURES

Injection Pressure

Molding pressures for DuPont™ Elvax® resins are usually low - for most machines, in the range of 35-100 MPa (5 000-15 000 psi). Higher molding pressures often cause surface roughness and poor gloss.

Injection Rate (Filling Speed)

The injection forward speed control should be adjusted to produce slow ram speed, since rapid filling of the mold cavity usually causes turbulence at the gate, producing a rough surface on the molded part. Turbulence varies with the type of gate used (see Gates and Runners under Mold Design), but slow fill speed is generally better than fast.

Cycle Time

Molding cycle time for Elvax® resins is usually equal to or slightly longer than that used for low density polyethylene. Because of the flexibility of the resin, some parts may require longer cooling time to obtain satisfactory ejection.

Ejection Lubricants

Spray-on lubricants may be needed to aid ejection of some moldings, especially those with little or no draft or taper on the sides. Fluorocarbon lubricant sprays are often used. With moldings that are particularly difficult to eject, aerosol spray waxes have been used with good results. Since Elvax® resins have much higher coefficient of friction than most other plastics, they can be used as friction surfaces to prevent slipping. For such use or where the part must be printed or decorated or welded, ejection lubricants must be carefully chosen to avoid residual lubricant on the part.

Screw Speed and Back Pressure Settings

While these settings are not usually critical for Elvax® , they perhaps deserve more attention than for polyethylene molding. It is usually desirable to set the speed and back pressure as low as feasible, consistent with the other requirements of cycle and color blending. Low screw speed and back pressure keep mechanical working of the resin to a minimum and prevent overheating.

Regrind

Because of the rubber-like nature of Elvax® resins, scrap grinding requires sharp cutter blades, set to minimum clearance of 0.075-0.125 mm (0.003-0.005 in.) and the moldings should be cool. Screens used in the grinders should have a minimum opening of 6.35 mm (0.250 in.) and a maximum opening of 9.525 mm (0.375 in.).

Since scrap handling is difficult, scrap should be minimized by the use of hot runner molds or minimum length runners. Care must be taken that scrap resin to be reused has not been degraded. Heating above the maximum recommended temperature (220ºC/425ºF) or excessive residence time in the heating cylinder can seriously affect the physical properties of Elvax® resins. Residence time in the cylinder at or near the maximum recommended melt temperature should not exceed twenty minutes.

Coloring

Elvax® resins are colored using the same procedures and pigments used for low density polyethylene. Since parts molded of natural Elvax® resins can be quite transparent, dry coloring can produce semitransparent to opaque colors. Color concentrates based on Elvax® resins are preferred for ease of blending, but concentrates based on low density polyethylene may also be used.

As with other polyolefin resins, pigment coloring is usually preferred to dye coloring for applications requiring light fastness or resistance to fading.

SHUTDOWN PROCEDURES

Purging Elvax® from the Cylinder

Purging both ram and screw type heating cylinders of Elvax® resins with either high or low density polyethylene has proved satisfactory. No unusual procedures are required.

Overnight Shutdown

No unusual precautions are required for leaving Elvax® resins in the heating cylinder overnight or over a weekend. If the machine is operating near the upper recommended melt temperature, all cylinder heaters should be turned off and the cylinder should be purged for a few minutes until the temperatures begin to drop. For a planned shutdown of several weeks duration, purging with polyethylene is recommended.

MOLD DESIGN

In designing molds, it must be kept in mind that Elvax® resins resemble rubber in flexibility, toughness, elongation and friction. Uniform, low-stress ejection and generous draft angles (2'-5') are particularly important, since the resins are soft at ejection temperatures and have a high coefficient of friction and relatively low shrinkage. Other considerations are discussed below.

Materials of Construction

Normally used mold steels have been found satisfactory for Elvax® resins; however, corrosion resistant material is recommended to prevent rust and extend tool life.

Surface Finish

Transparent moldings and opaque, high gloss moldings may require highly polished mold surfaces. However, a matte or textured finish is recommended whenever possible for parts molded from Elvax® resins. This type of finish aids ejection and minimizes the effect on appearance of marks and scratches incurred in use.

Coolant Circulation

Cooling channels should be located and sized to provide uniform heat transfer, as rapid as possible without causing hot or cold spots. In some instances, auxiliary cooling channels are needed where heat is concentrated in the molding, such as opposite a sprue, near a tunnel gate, or at an especially heavy section. If core pins forming a hole in the molding are longer than about two pin diameters, they should be provided with internal cooling if at all possible.

Ejection

DuPont™ Elvax® resins are well suited to any mold which has large-area ejector pins or stripper rings and draft angles in the range of two to five degrees on a side. These conditions are seldom found in molds for plastics but are common in molds for rubber. The higher stiffness, higher compressive strength grades of DuPont™ Elvax® can be more readily ejected from molds with little or no draft angle than the more flexible grades, but draft should be allowed wherever possible.

Air ejection is often helpful. However, air pressure inside the part must be kept low to prevent distortion.

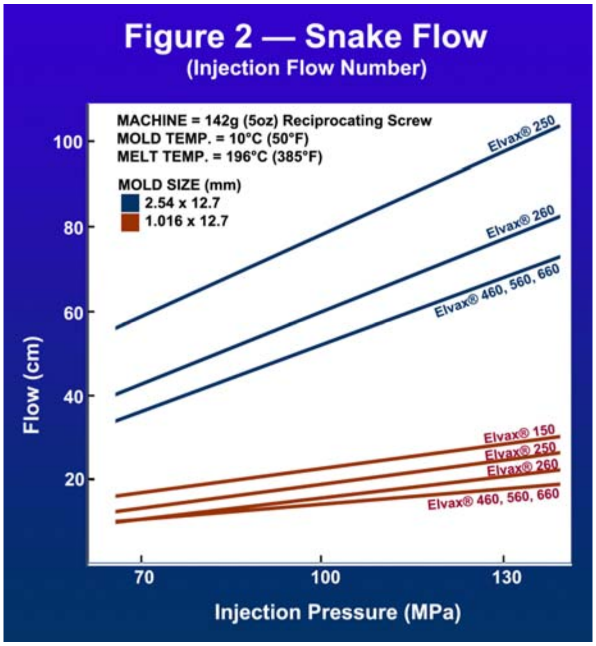
Undercuts should be carefully radiused to aid ejection and generally should be no more than 0.25-0.38 mm (0.010-0.015 in.) deep. Placing the undercut as near the ejector or stripper plate as feasible helps to avoid distortion of the body of the part.

Flow Distance

The snake flow data in Figure 2 show the flow distances obtainable with DuPont™ Elvax® resins having melt indices from 2.5 to 43. It should be noted that these flow distances are attained using a fast ram speed on the machine; in actual molding, a slower ram speed or lower pressure might be required to produce the desired surface finish. Whether or not more than one gate is needed to aid surface finish can be determined experimentally.

Flow into the cavity can be seriously affected by inadequate venting, which restricts the flow of air in front of the resin. While this is not usually a problem with the slow filling rates used for Elvax® , it is best to be safe by providing properly sized and located vents in the mold design. It is advisable to make the vent opening into the mold cavity broad and thin.

Because Elvax® resins tend to "flash" more than polyethylenes of comparable melt index, it is best not to be too generous with clearances and vent openings. Vent openings should be 0.025-0.038 mm (0.001-0.0015 in.) deep by 3.175 mm (0.125 in.) wide, with a 1.5-mm (0.06-in.) land relieved generously [8 mm x 3 mm (0.03 in x 0.1 in)] to the edge of the mold.



Gates and Runners

As stated earlier, molding surface finish is responsive to the rate at which the resin enters the mold cavity. How the resin enters the cavity is also very important. Because of the elastomeric nature of Elvax® resins, the transition from the runner through the gate and into the cavity should be as streamlined as possible. Fan gates, flash (film) gates and tab gates appear more satisfactory than other gate forms to reduce jetting and other surface blemishes.

Hot runner molding of DuPont™ Elvax® resins has been found to operate very smoothly in automatic molding with hot runner gates in the range from 1 to 2 mm (0.04 to 0.08 in) in diameter. Since molding temperatures are comparatively low, heat losses are less critical than with higher melting resins.

Tunnel (submarine) gating is also possible with these resins but the gate must have a very short length and a very sharp edge in order to shear cleanly.

Runner sizes for Elvax® resins usually will be similar to those for polyethylenes of comparable melt index. Very rough surfaced runners should be avoided, since runner roughness seems, in some moldings, to have an effect on the gloss of the part.

Shrinkage

Molding shrinkage of Elvax® resins is affected by many variables, including vinyl acetate content of the resin, wall thickness and shape of the part, melt temperature, mold temperature and pressure. Figure 3 illustrates the effect of vinyl acetate content and thickness. As the chart indicates, the shrinkage factor for commercial grades of Elvax® used for molding (9%-33% vinyl acetate) ranges from approximately 0.00 I mm/mm (in/in) to 0.0 16 mm/mm (in/in). Because of the many parameters that must be taken into account when sizing the mold, it is strongly recommended that a test cavity be used to determine actual part shrinkage.

OPTIMIZING MOLDING CONDITIONS

Table 2 summarizes the effect of operating variables on part quality. Suggestions for solving specific problems encountered in injection molding are presented in the troubleshooting checklist appended as Table 3.

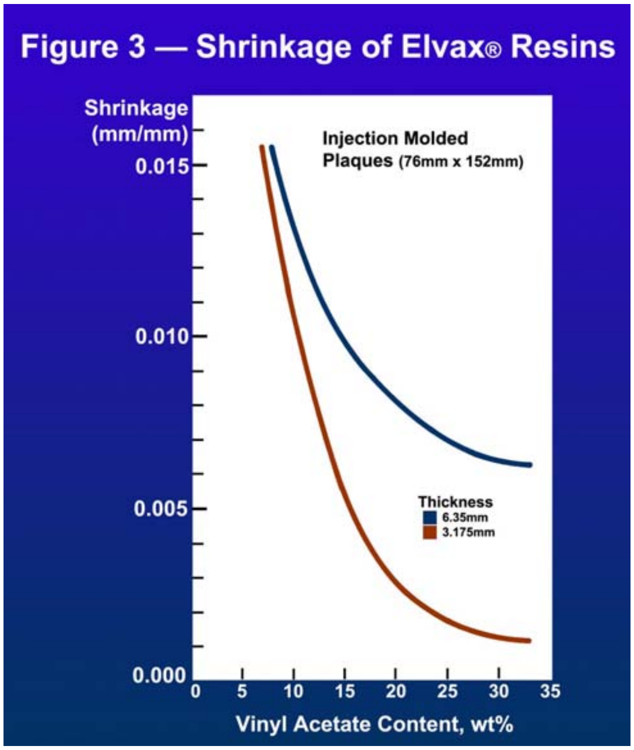


Table 2 – The Influence of Molding Variables on Part Quality

	Melt Temperature	Injection Pressure	Mold Temperature	Screw Forward Time	Fill Speed	Feed Condition	Cycle Time
Minimum Shrinkage	Low[1]	Maximum[2]	Low[3]	Long	Fast[4]	Pad	Long[5]
Minimum Warpage	Low[1]	Minimum	Medium to High[3]	Short[6]	Fast[4]	Starve[7]	Long[5]
Maximum Dimensional Stability	Low[1]	Medium	Medium[3]	Medium	Fast[4]	Starve[7]	Long[5]
Maximum Impact Strength	High[8]	Medium to High	Low to Medium[3]	Medium	Fast[4]	Pad	Medium
Best Surface Appearance	Medium to High[8]	Maximum[2]	Medium to High[3]	Medium to Long	Medium to Fast[4]	Pad	Long[5]
Best Overall Quality	Medium to High[8]	Maximum[2]	Medium[3]	Medium	Medium to Fast[4]	Pad	Long[5]

[1] Low side of adequate.
[2] Maximum short of flash.
[3] Low: below 5ºC (40ºF). Medium: 5-25ºC (40-80ºF). High: above 25ºC (80ºF).
[4] As fast as possible provided surface and venting are adequate.
[5] Greater than minimum.
[6] To prevent packing.
[7] Short of metal-to-metal contact.
[8] Avoid overheating.

Table 3 – Troubleshooting Checklist

Defect	Possible Cause	Problem-Solving Suggestions
I. Short Shots - At Start of Injection Molding Operation - Screw Is Bottoming	A. Insufficient material	Carefully check the following: 1 . Hopper for sufficient material. 2. Feed system for blockage. 3. Feed setting - increase as necessary.
	B. Insufficient machine capacity	If (1) through (3) do not provide sufficient feed, it will be necessary to (a) place mold in higher shot capacity press, or (b) block off some of the mold cavities.
II. Short Shots - At Start of Injection Molding Operation - Screw Not Bottoming	A. Too short injection time	If the screw is in motion at the end of the injection cycle, increase injection cycle
	B. Insufficient injection pressure	If screw is completely stopped before end of injection cycle, increase injection pressure. Operate at maximum injection speed. (Booster)
	C. Cylinder temperature too low	If at maximum injection pressure, raise cylinder temperatures (see Table 1 for suggested temperatures).
	D. Burned out nozzle or cylinder heater bands	Check all nozzle and cylinder heater bands with pyrometer or ammeter.
	E. Blocked or frozen nozzle, sprue or gate	Check nozzle orifice, sprue and gates for foreign or unmelted material.
	F. Sprue bushing, runners, vents and/or gates offering excessive resistance to flow	Enlarge as necessary.
	G. Material of too low flow rate	Use an Elvax® resin with higher flow rate.
III. Short Shots - After Period of Successful Injection Molding	A. Check Items A, D and E in Part 11	See applicable suggestions above.
	B. Loss of injection pressure	1. Check for defective pumps or valves. 2. Check for low oil level. 3. Check for overheated oil supply, possibly due to loss of coolant or plugged heat exchanger.
	C. Inadequate venting (usually accompanied by burned or charred spots)	Check for vent blockage.
	D. Insufficient material	See applicable suggestions in Part 1, Item A.
IV. Short Shots - Cyclic During Injection Molding Operations	A. Cylinder temperature control inadequate	Consult technical service representatives of molding press and/or temperature controllers.
	B. Inconsistent cycles	1. Check timers vs. stopwatch for consistent time. 2. Check screw-in-motion time. (inconsistent time indicates nonuniformity of melt.) 3. If on semiautomatic cycle, check for variations in operator controlled portion of cycle. 4. Check hydraulic system for sticking solenoid valves. 5. See suggestions in III B

Table 3 – Troubleshooting Checklist (continued)

Defect	Possible Cause	Problem-Solving Suggestions
V. Flashing	A. Material too hot	Reduce temperatures (see Table 1).
	B. Injection pressure too high	Reduce injection pressure.
	C. Clamp end of press out of adjustment	Reset toggles or increase clamp pressure.
	D. Too much material being injected into mold	1. Reduce feed. 2. Reduce packing.
	E. Flash or foreign material acting as high spot on mating surfaces of mold	Inspect land areas, etc. of mold carefully, Clean if necessary.
	F. Insufficient venting or vent blockage forcing material from cavity area	1. Inspect and clean vents if necessary. 2. Enlarge vents. Vents should be not more than 0.038mm (0.0015 in) in depth.
	G. Clearances in vents, KO's, etc. too great	1. Clearance should be not more than 0.038 mm (0.001 5 in). 2. If part geometry allows, use lower flow rate Elvax® resin.
	H. Mold surfaces, cores and/or cavity insert out of register	Remove mold, overhaul and correct register.
	1. Mold or platens warped or "bumped"	Check and overhaul if necessary.
	J. Injection pressure unevenly distributed in mold	Cavity layout should be balanced.
	K. Projected area too large for available clamping pressure	1. Shift to press with greater available clamping pressure. 2. Reduce number of cavities.
VI. Ejection Difficulties	A. Parts flashing in mold	Check Part V.
	B. Material too highly packed in cavity (mainly with large gates)	1. Reduce pack and adjust towards starve feed. 2. Reduce injection screw forward time. 3. Reduce injection pressure.
	C. Pieces deform during ejection (part soft)	1. Increase overall cycle. 2. Reduce mold temperature. 3. Incorporate air injection in conjunction with mechanical methods. 4. Sandblast, vapor hone, or draw polish core in direction of ejection.
	D. Parts stick to core due to highly polished surfaces	Check Item C-4 preceding.
	E. Mold conditions	
	1. General surface and mold defects	Overhaul, polish, and remove sharp or drastic undercuts.
	2. Insufficient draft or tapers on cavities, cores or sprues	Increase draft as recommended under "Mold Design"
	3. Improperly designed undercuts	Undercuts should not have sharp angles but should be tapered to ease ejection.
	4. Poor or mismatched sprue bushing to nozzle radii and/or orifices	Align nozzle and sprue bushing.

Table 3 – Troubleshooting Checklist (continued)

Defect	Possible Cause	Problem-Solving Suggestions
VII. Warpage or Part Deformation	A. High level of molded-in stresses due to:	
	1. Excessive packing of cavity	Reduce injection pressure and/or operate on starve feed.
	2. Cavities filling too slowly	Increase cylinder temperatures (see Table 1) and/or fill rate. (Booster)
	3. Melt temperature too low or nonhomogeneous	Increase cylinder temperature (see Table 1) or increase back pressure.
	B. Part ejected too hot	1. Reduce mold temperature.
		2. Increase overall cycle.
		3. Reduce cylinder temperature.
		4. Use of shrink or cooling jigs may also be considered.
	C. Improperly designed ejector mechanism	
	D. Improper part design (nonuniform walls)	
	E. Improper location and/or design of gates	
	F. Improper design of undercuts, ribs, bosses, threads, etc.	
	G. Inadequate mold cooling (capacity of system, lack of balance in mold halves, differential cooling)	
	H. Misaligned or shifted cores	
	I. Inadequate runner system	
	J. Improper or lack of venting	
VIII. Excessive Shrinkage	A. Gates not frozen off	Increase injection screw forward time.
	B. Insufficient effective injection pressure in cavities	
	1. Gates too small or improperly designed	Increase gate size or shorten land length.
	2. Runner system improperly designed (diameter and layout)	Increase runner size to decrease resistance to polymer flow.
	3. Melt temperature too low	Increase cylinder temperatures (see Table 1)
	4. Flow rate of material too low	Use higher melt index Elvax® resin if possible.
	5. Nozzle orifice too small	Use nozzle with larger orifice opening.
	C. Injection pressure too low	Increase injection pressure slowly to borderline flash conditions (Note Part VII-A).
	D. Mold temperature too high	Reduce mold temperature.
	E. Part ejected too hot	Increase mold closed time.
	F. Insufficient material in cavity	Increase feed to very slight pack (Note Part VII-A).
	G. Insufficient dwell time	Increase injection screw forward time.
IX. Sinks, Shrink Marks, Voids, Bubbles	With the possible exception of Item B-4, the comments in Part VIII (Excessive Shrinkage) generally apply to the control of sinks and voids. Low flow rate resins may assist in minimizing voids in heavy section, easy-to-fill parts. Also, the use of SLOW injection speeds might help in the control of sinks and voids.	

Table 3 – Troubleshooting Checklist (continued)

Defect	Possible Cause	Problem-Solving Suggestions
X. Burning, Charring, Black Specks or Brown Streaks	A. Material too hot	1. Reduce cylinder temperatures (see Table 1). 2. Shorten cycle.
	B. Inadequate or blocked venting	1. Inspect and clean vents. 2. Vent at point of burning.
	C. Material entering cavities too rapidly	Reduce injection speed. (Sufficient venting (B-2) often corrects this problem.)
	D. Material hanging in heating cylinder and/or nozzle (generally indicated by specks or streaks in molded item)	Clean nozzle and cylinder with purge compound or disassemble and clean.
	E. Questionable quality regrind	Segregate and sort regrind critically.
	F. Material degraded due to heat caused by shear	1. Reduce rate of fill. 2. Open restricted area(s) - gates, runners, sprue, nozzles, etc.
XI. Degradation	Degradation of Elvax® resin is normally observed as a marked increase in the fluidity of the melt, brown streaks, and/or brittleness of the molded part. Refer to Parts IV-A and X-A through E. Also check:	
	A. Burned out thermocouple	Check all thermocouples.
	B. Temperature controller malfunctions	1. Check for sticking relays. 2. Check for sluggish or stuck meter movements in controller. 3. Calibrate controller.
	C. Improper shutdown procedures (over weekends or periods of interrupted production)	Purge machine thoroughly. Displace cylinder holdup at least once. Rule-of-thumb on holdup is 1.5 times the maximum capacity of machine in grams (ounces).
XII. Dimensional Variations - See Also Part VIII	A. Nonuniform feed	
	1. Machine conditions	Check operation of feed mechanism.
	2. Material condition	Check pellet size for variations.
	B. Cylinder temperature control inadequate	See Part IV-A.
	C. Inconsistent cycles	See Part IV-B
	D. Insufficient machine capacity	See Part IB (for consistency of dimensions when molding Elvax®, it is suggested shot size not exceed 70% of machine's plasticating capacity).
	E. Inadequate control of mold temperatures	

Table 3 – Troubleshooting Checklist (continued)

Defect	Possible Cause	Problem-Solving Suggestions
XIII. Surface Defects on Molded Articles	A. Excessive mold lubricant	1. Wipe mold surfaces thoroughly. 2. Use lubricant sparingly.
	B. Moisture on cavity surfaces	1. Wipe mold surfaces thoroughly with rag moistened with alcohol. 2. Raise mold temperature. 3. Apply anti-sweat material to outer surfaces of mold base.
	C. Material conditions	
	1. Contamination by foreign material	
	2. Bubbles due to:	
	a. Trapped air	Raise rear cylinder temperature.
	b. Moisture condensing on cold pellets when moved into warm, humid processing area	1. Use dryer to remove condensed moisture. 2. Store minimum of one day's materials requirements in processing area.
	c. Unmelted particles in part	See Parts I-B, 11-C, II-D, and 11-G.
	D. Delamination due to:	
	1. Contamination of material	Check material for foreign matter.
	2. Material too cold	Increase cylinder temperature (see Table 1)
	3. Excessive packing of cavity	See Part VII-A.
	E. Specks due to poor pigment dispersion	See Part XIV
	F. Irregular, cloudy or orange peel surface due to:	
	1. Material too cold	See Part VII-A - 2 and 3.
	2. Mold too cold	
	3. Insufficient effective injection pressure in cavities	See Part VIII-B.
	4. Moisture on mold and/or pellet surfaces	See Part XIII-A and B.
	G. Flow lines due to:	
	1. Improper gate design and/or location	See "Gates and Runners"
	2. Material being too cold	Raise cylinder temperatures (see Table 1)
	3. Injection speed too slow	Increase injection speed.
	4. Flow rate of material too low	Use higher melt index Elvax® resin.
	5. Jetting of melt	1. Decrease injection speed. 2. Correct gate design.
	H. Weld lines due to:	
	1. Material too cold at point of weld	Raise cylinder temperatures and/or mold temperature (see Table 1)
	2. Material flowing too slowly at point of weld	Increase injection speed.
	3. Weld line being too far from gate	Improve venting or install overflow tab.
	4. Insufficient effective injection pressure in cavities	1. Establish positive cushion on feed scale. 2. Insure positive check ring seal.

Table 3 – Troubleshooting Checklist (continued)

Defect	Possible Cause	Problem-Solving Suggestions
XIV. Poor Color Dispersion	A. Poor dispersion nozzle	Use adequate dispersion nozzle.
	B. Insufficient mixing in machine	Increase back pressure.
	C. Resin not completely and/or uniformly wetted	Use wetting agent (for dry color).
	D. Poor pigment blending	Use adequate mixing time during blending
	E. Improper concentrate	Select concentrate base with properties as near as possible to that of resin being molded, and of the same or slightly higher flow rate.
XV. Brittleness	A. Stock temperature too low	Increase cylinder temperature (see Table 1)
	B. Mold temperature too high	Decrease mold temperature.
	C. Degraded material from cylinder, or contamination	Purge foreign material from cylinder before starting operation.
	D. Use of improper color concentrates	Use concentrates based on ELVAX resins.
	E. Improper design	Provide adequate radii at corners and notches and in thread design
	F. Voids	Increase cavity pressure; allow sufficient dwell time.
	G. Pigment agglomerates	See Part XIV.

For questions or more information about DuPont™ Elvax®:

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