

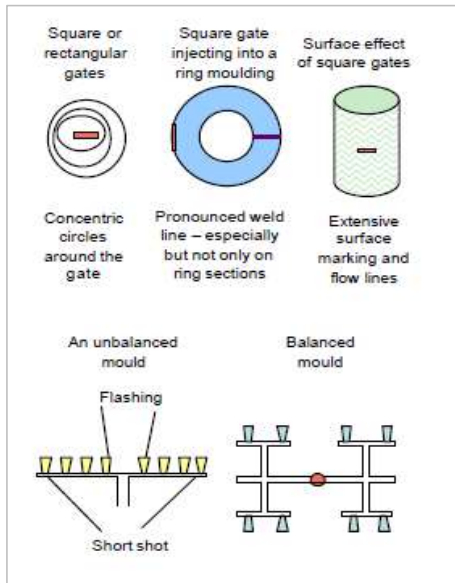
Injection Moulding Troubleshooting Guide

EVOPRENE[®] TPE compounds

This guide is intended for production troubleshooting. Please contact us with any questions.

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Processing EVOPRENE TPE compounds by injection moulding is relatively easy providing certain basic principles are adhered to. The thermoplastic elastomers used are styrene block copolymers of the type SBS (styrene-butadiene-styrene) or SEBS (styrene-ethylene butylene-styrene) or similarly structured polymers. These polymers have long elastomeric chains of polybutadiene (SBS) or poly(ethylene butylene) (SEBS) called midblocks which are terminated with hard polystyrene endblocks. The midblocks provide the rubber like, elastomeric characteristics whilst the end blocks act as crosslinks. Because the crosslinks are physical rather than chemical they are fully reversible: when the EVOPRENE TPE compounds are within their defined temperature performance range, typically -50 to +100-120°C, depending on grade, they behave as elastomers but when heated under pressure to process temperature, typically 170-220°C, they flow like thermoplastics and can be shaped in a mould. On cooling again they resume their elastomeric behaviour.



Runner and gate design is one of the most important factors when injecting EVOPRENE TPE compounds. The softer the compound, the more important this becomes. Full round runners and gates give by far the best results with the runner tapering into the gate rather than having a sharp shutdown. Gates should be generous – for cold runner systems the full round section should be approximately half the maximum part thickness with a minimum of 0.7mm diameter. This can be reduced to one third when hot runners are used although the minimum should still be the same 0.7mm. Examples of the effects of using square, rectangular or undersized gates are shown on the left.

A very important requirement of hot runner systems is the use of shut-off valves in the hot runner tips. This is to prevent drooling of the hot elastomer which then cools to a cold mass at the gate area. In most cases the next shot injects through this mass leaving a hard lump at the gate but in some cases the hard mass is forced into the bulk of the moulded component. Shut-off valves prevent this from occurring.

A properly balanced tool is necessary to ensure good mouldings are produced in cold runner tools. As can be seen in the illustration the outside shots in an unbalanced tool will not be fully formed (short shot) whereas those cavities which receive the compound first will be overpacked and will have a tendency to flash. To avoid this "H" shaped or similar tools should be used where the distance from the sprue bush to each cavity is the same.

Remedy
X = primary
? = secondary

	Temperatures						Pressure						Time					
	Melt Temp		Mould Temp		Increase Nozzle Temp	Decrease Temp in Feed Zone	Injection		After		Screw-back		After Pressure		Filling Time		Cool Time	
	Increase	Decrease	Increase	Decrease			Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
Flow marks	X		?									?					X	
Beach lines	X	?					?										?	
Weld lines	X		?		?		?					?					?	
Jetting	?				?							?			X			
Moisture streaks		?	?			?						?					?	
Voids		?		?					X				?					
Shrinkage*	?		?				?			?			?			?	?	
Dull / uneven surface	X		?		?							?			X			
Degradation		X										?			?			
Delamination	?				?		?			X	?		?		?		?	
Sink marks		?							X				X				?	
Short shots	?						X		?				?				?	
Sprue / nozzle leakage							Delay											
Burning		?						?				?			X			
Screw does not return						?						X						
Flashing		?						?				?			?			
Difficulty removing sprue		?		?						?			?				X	
Long cycle time		X		?								?		?				?

*Shrinkage due to molded-in stresses

EVOPRENE family	Max safe melt	Shrinkage	Injection Speed	Cooling
Super G	280°C / 535°F	Filled: 1.2 - 2.0% Unfilled: 2.2 - 3.5% Depends on hardness	Medium speed with low-to-medium pressure	Cooling time depends on the thickness of the moulding. Refer to figure 1 on back page which illustrates the different cooling times that can be expected from the different families of EVOPRENE. Super G grades can be de-moulded at much higher temperatures than standard grades.
HP	250°C / 480°F			
G	250°C / 480°F			
COGEE	280°C / 535°F		Fast speed	
GC	240°C / 465°F		Medium - Fast	
Standard	220°C / 430°F	0.5 - 1.2%	Fast speed, medium pressure	

EVOPRENE family	All temps in celcius (°C)					Drying	Hold Pressure
	Mould Temp	Barrels					
Super G	40-60	200-220	200-220	200-220	200-220	Predrying not needed, but check stock >6 months old. If specific gravity >1.15, dry for 4 hours at 60-80°C.	Sufficient to pack the mould.
HP	40-60	160-190	160-190	160-190	160-190		
G	30-60	170-190	170-190	170-190	170-190		
COGEE	30-60	250-270	250-270	250-270	250-270	Predry for 4-6 hours at 80°C (175°F)	
GC	20-40	170-190	170-190	170-190	170-190	Predrying not needed, but check stock >6 months old. If specific gravity >1.15, dry for 4 hours at 60-80°C.	
Standard	15-30	160-180	160-180	160-180	150-170		

EVOPRENE family	All temps in fahrenheit (°F)					Regrind	Vending
	Mould Temp	Barrels					
Super G	105-140	390-430	390-430	390-430	390-430	All sprues, runners, and unwanted parts can be regrind and blended with virgin EVOPRENE of similar type to produce satisfactory mouldings. Loadings of around 20% have been found to be acceptable.	Vents should be 0.02-0.05mm (1-2 thou) deep added at the point.
HP	105-140	320-375	320-375	320-375	320-375		
G	85-140	340-375	340-375	340-375	340-375		
COGEE	85-140	480-520	480-520	480-520	480-520		
GC	70-105	340-375	340-375	340-375	340-375		
Standard	60-85	320-355	320-355	320-355	320-355		

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	Mould											Screw			Miscellaneous							
	Mould locking force		Increase gate size	Check gate location	Polish / blast treatment	Maintenance required	Polish sprues and runners	Increase sprues and runners	Introduce venting	Introduce cold slug	Check cavity balance	Introduce air ejector	Rotation speed		Inject with rotation screw	Unblock nozzle	Pre-dry material	Avoid contamination	Ensure pellet flow in hopper	Check nozzle / sprue bush radius	Metering	
	Increase	Decrease											Increase	Decrease							Increase	Decrease
Flow marks					?								?									
Beach lines								?														
Weld lines		?		?				X					?									
Jetting			X	?					?							X	?				X	
Moisture / streaks		?						?								X						X
Voids			?	?			?			?												
Shrinkage*				?						X												
Dull / uneven surface			?		?				?								?					
Degradation													?									?
Delamination								?		?						?	X				X	
Sink marks			?	?			?			?	?											
Short shots			?	?			?			?					?							
Sprue / nozzle leakage															?						?	
Burning		?						?														
Screw does not return													?			?						?
Flashing	X					?				?												
Difficulty removing sprue							?															?
Long cycle time								?		X						?						?

*Shrinkage due to molded-in stresses

Type and screw design

All grades are best processed on screw ram machines fitted with general purpose screws. Plunger machines are not recommended but can produce acceptable small or prototype parts.

Mould design

Very often the crucial part. Incorrect mould design is the most frequent cause of moulding problems for EVOPRENE compounds. Avoid unbalanced moulds; design to inject against a wall to avoid jetting. Follow the guidelines in this document and/or contact our technical department for further information and help.

Runners

Full round runners tapering into the gate area are necessary for best results. They should be kept as short as possible and must be balanced in multi-cavity designs. Trapezoidal gates are used in low-cost tooling but tend to restrict flow. Hot, cold, and insulated runners are all suitable.

Gates: cold runner

Full round gates should always be used with a diameter half the maximum part thickness, minimum 0.7mm. It is best to inject against a surface so submarine or wrinkle gates give good results particular with softer grades. Tab and film gates are acceptable providing they are large enough. Avoid square or rectangular gates and sharp shut-downs.

Gates: hot runner

Full round gates are essential, but diameter can be reduced to one-third the maximum part thickness with a minimum of 0.7mm. To avoid drool from hot runner tips, always fit shut-off valves in the hot runner tips. Failure to include shut-off valves will lead to the formation of a cold mass. This is usually seen at the gate but sometimes can be pushed around the moulding. Retrospective fitting of valve gates is very difficult and costly, so ensure they are specified on initial mould build.

Multi-component moulding for soft-touch

This is best accomplished by comoulding with more than one barrel. Rotary tools or retracting core systems can be used. Component design determines the moulding sequence, but better bonds can be achieved by moulding the EVOPRENE first, then injecting the thermoplastic, usually at a higher temperature. Effective shut-off is achieved through the use of crush beads or similar. Insert moulding is effective for small volume parts, but bond strengths are normally less good and mechanical keying is recommended. Please contact our technical department for further assistance.

Venting

Best added after initial mould trials. Vents 0.02-0.05mm (1-2 thou) deep should be located at the final fill point to eliminate air traps and weld lines and prevent burn marks.

Ejection

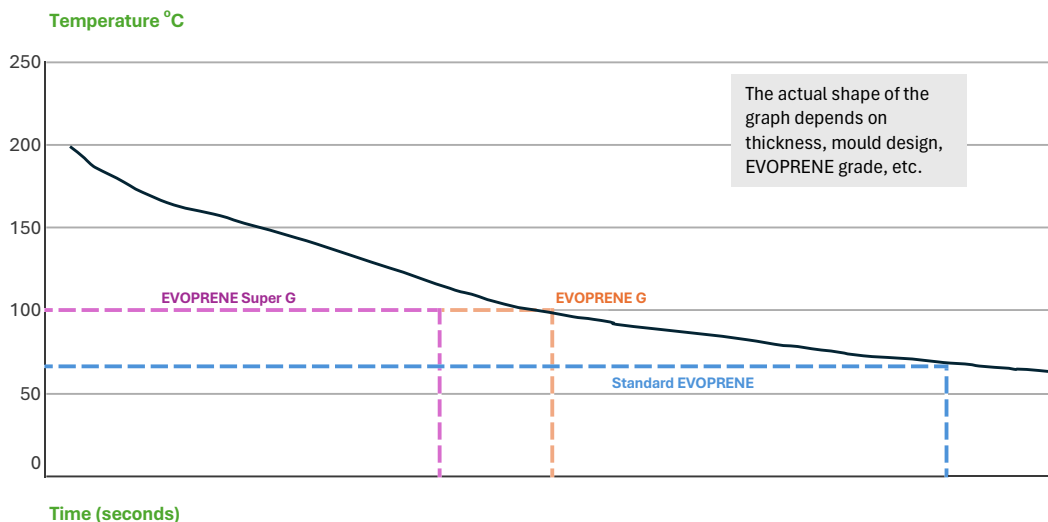
A stripper plate is best. Ejector pins where used should be as large as possible and sited for maximum support. Air ejection is used to break the vacuum for deep draw parts.

Cooling:

Cooling time depends on the thickness of the moulding. This graph illustrates the different cooling times which can be expected from the different families of EVOPRENE. For example, EVOPRENE Super G grades can be demoulded at much higher temperatures than standard grades.

Cooling time versus temperature

FIGURE 1



Shrinkage

Mould shrinkage depends on a number of factors. These include gate position, cooling time, injection speed and pressure, and hold pressure. EVOPRENE grades shrink more along the line of flow than across due to the anisotropy of these types of materials. This makes prediction of shrinkage quite difficult - but, **as a general guide, the following figures can be used as a starting point.** It is always advisable to check the shrinkage in the actual mould with the grade to be used before cutting metal.

EVOPRENE family	Unfilled Specific Gravity: 0.90		Partly Filled Specific Gravity: 0.95-1.10		Filled Specific Gravity: 1.15-1.20	
	<70A	>70A	<70A	>70A	<70A	>70A
Super G	3.50%	2.5-3.0%	2.0-2.5%	2.00%	1.8-2.2%	1.8-2.2%
HP	3.50%	2.5-3.0%	2.0-2.5%	2.00%	1.8-2.2%	1.8-2.2%
G	3.50%	2.5-3.0%	2.0-2.5%	2.00%	1.8-2.2%	1.8-2.2%
COGEE	3.50%	2.5-3.0%	2.0-2.5%	2.00%	1.8-2.2%	1.8-2.2%
GC	3.00%	2.50%	2.50%	1.6-2.0%	1.6-2.0%	1.2-1.6%
Standard	2.0-2.5%	1.8-2.2%	1.8-2.2%	1.3-1.8%	1.0-1.5%	0.8-1.2%

Recycling

EVOPRENE TPE compounds are fully recyclable at all stages in their use cycle. After the useful life of the part has expired, EVOPRENE compounds can be recycled although in some circumstances, additional stabilisation will be necessary.

Regrind

All scrap, sprues, runners, misshapen parts, etc., can be regrind and reused. Care should be taken to avoid contamination, and granulator knives should be very sharp. A loading of regrind of 20% is recommended, but higher loadings are possible.

Purging

It is essential to purge the barrel clean of other materials before processing EVOPRENE grades. For all compounds in the G family, polypropylene is recommended as a purge material.

Stabilisation

EVOPRENE TPE compounds are often coded to indicate various stabilisation systems. In all cases, please consult with your Alphagary representative to ensure the proper stabilisation for the intended end product(s) is utilised.