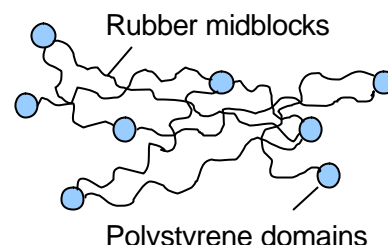


Injection Moulding Guide

This guide is only intended to serve as a guideline for production troubleshooting. For further details, please contact our technical department.

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™ 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.



Square or rectangular gates



Concentric circles around the gate

Square gate injecting into a ring moulding



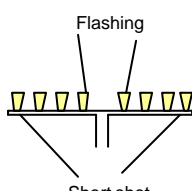
Pronounced weld line – especially but not only on ring sections

Surface effect of square gates



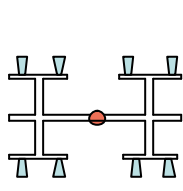
Extensive surface marking and flow lines

An unbalanced mould



Short shot

Balanced mould



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.

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Additional Information about:

- Material Selection
- Processing
- Mould Shrinkage
- Chemical Resistance
- Packaging & Labeling

AlphaGary
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Know-How!

can be obtained by visiting www.alphagary.com, emailing us at enquiries@alphagary.com, or contacting one of our offices

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	Temperature						Pressure						Time						
	Melt Temperature		Mould Temperature		Increase nozzle temperature	Decrease temperature in feed zone	Injection Pressure		After Pressure		Screw back pressure		Delay injection pressure	After pressure time		Filling time		Cooling 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		?	?			x					?							?	
Voids		?		?					x					?					
Shrinkage *	?		?					?		?				?				?	?
Dull / uneven surface	x		?		?						?					x			
Degradation		x									?						?		
Delamination	?				?			?		x	?				?		?		
Sink marks		?							x					x				?	
Short shots	?						x		?					?				?	
Sprue/nozzle leakage												?							
Burning		?									?					x			
Screw does not return					?						?					x			
Flashing		?						?			?					?			
Difficulty removing sprue		?		?						?				?				x	
Long cycle time		x		?							?			?					?

Remedy
x = primary
? = secondary

* Due to moulded-in stresses

Product Line	Max Safe Melt	Shrinkage	Injection Speed	Cooling
Evoprene Super G	280°C (535°F)	Filled: 1.2 – 2.0% Unfilled: 2.2 – 3.5% Depending on hardness	Medium speed with low to medium pressure Fast speed Medium – Fast	Cooling time depends on the thickness of the moulding. The graph (Figure 1, back page) illustrates the different cooling times which can be expected from the different types of Evoprene. Super G grades can be demoulded at much higher temperatures than standard
Evoprene HP	250°C (480°F)			
Evoprene G	250°C (480°F)			
Evoprene COGEE	280°C (535°F)			
Evoprene GC	240°C (465°F)			
Evoprene / Evoprene CE	220°C (430°F)			

Product Line	Mould Temp °C	Barrel Temps °C				Drying	Hold Pressure
Evoprene Super G	40-60	200-220	200-220	200-220	200-220	Predrying not needed, but check stock > 6 months old if S.G. > 1.15 (dry at 4 hours at 60-80C) Pre-dry for 46 hours @ 80C (176F)	Sufficient to pack the mould
Evoprene HP	40-60	160-190	160-190	160-190	160-190		
Evoprene G	30-60	170-190	170-190	170-190	170-190		
Evoprene COGEE	30-60	250-270	250-270	250-270	250-270		
Evoprene GC	20-40	170-190	170-190	170-190	170-190		
Evoprene / Evoprene CE	15-30	160-180	160-180	160-180	150-170		

Product Line	Mould Temp °F	Barrel Temps °F				Reground	Venting
Evoprene Super G	105-140	390-430	390-430	390-430	390-430	All sprues, runners and unwanted parts can be reground and blended with virgin Evopren [®] ™ of similar type to produce satisfactory mouldings. Loadings of around 20% have been found acceptable.	Vents should be 0.02 – 0.05mm (1-2 thou) deep added at the point
Evoprene HP	105-140	320-375	320-375	320-375	320-375		
Evoprene G	85-140	340-375	340-375	340-375	340-375		
Evoprene COGEE	85-140	480-520	480-520	480-520	480-520		
Evoprene GC	70-105	340-375	340-375	340-375	340-375		
Evoprene / Evoprene CE	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	Increase
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												?				?			X	?			
Flashing	X						?			?		?											
Difficulty removing sprue							?															?	
Long cycle time				?					?		X					?							?

Remedy
X = primary
? = secondary

- Due to moulded-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 guide 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 winkle gates give good results particularly with softer grades. Tab and film gates are acceptable providing they are large enough. Avoid square or rectangular gates and sharp shut downs.
Hot runners	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.

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Cooling Cooling time depends on the thickness of the moulding. The graph illustrates the different cooling times which can be expected from the different types of Evoprene. E.g. Evoprene Super G grades can be demoulded at much higher temperatures than standard grades.

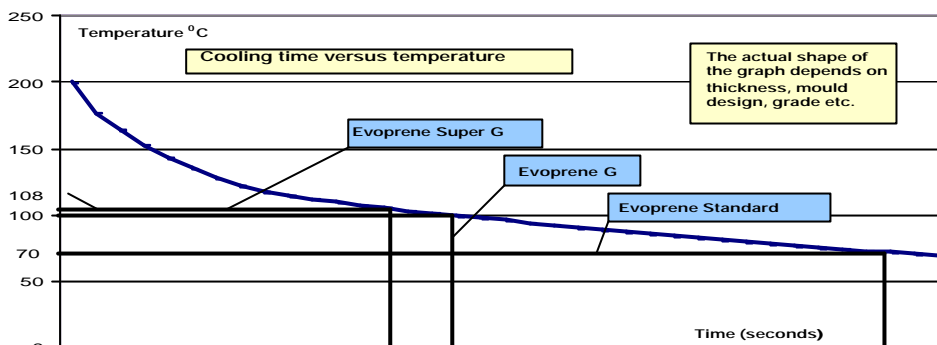


Figure 1

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 an actual mould with the grade to be used before cutting metal.

	Unfilled		Partly Filled		Filled	
	S.G. 0.90		S.G. 0.95 – 1.10		S.G. 1.15 – 1.20	
	< ShA 70	> ShA 70	< ShA 70	> ShA 70	< ShA 70	> ShA 70
Evoprene Super G						
Evoprene HP						
Evoprene G	3.5%	2.5 – 3.0%	2.0 – 2.5%	2.0%	1.8 – 2.2%	1.8 – 2.2%
Evoprene COGEE						
Evoprene GC	3.0%	2.5%	2.5%	1.6 – 2.0%	1.6 – 2.0%	1.2 – 1.6%
Evoprene	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 parts 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 reground 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 Evoprene™ G based compounds, polypropylene is recommended as a purge material.

Stabilisation Evoprene™ TPE compounds are coded with a 4 digit masterbatch number in addition to their grade reference, e.g. Evoprene™ 075 Natural 1000, Evoprene™ G 963 Black 5156 or Evoprene™ G 645 Grey 5443. The masterbatch contains the colour, if any, and also the stabilisation system. Various stabiliser systems are available to meet the different requirements. Some common ones are as follows:
 General Purpose Natural: 1000, 2436, 4140, 4305
 General Purpose Black: 5156, 4311
 UV stabilised: Natural 4262, Natural 4140, Black 4286
 Food Contact*: 4179, 4213, 4440

* It is the responsibility of the end user to ensure any grade intended for use in food contact applications is fully tested in contact with the particular foods. For details please see the "Evoprene™ General Information" Sheet or contact our technical department for further advice.

For more information, please feel free to contact us:	AlphaGary Ltd Belar Way, Melton Mowbray Leicestershire LE13 0DG UK +44 (0) 1664 502222 +44 (0) 1664 502250 fax	AlphaGary Corporation 170 Pioneer Drive Leominster, MA 01453 USA 978 537 8071 978 840 0856 fax	AlphaGary Canada Ltd 5 Pinelands Avenue Stoney Creek, Ontario CAN L8E 3A4 905 662 5735 905 664 3599 fax
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