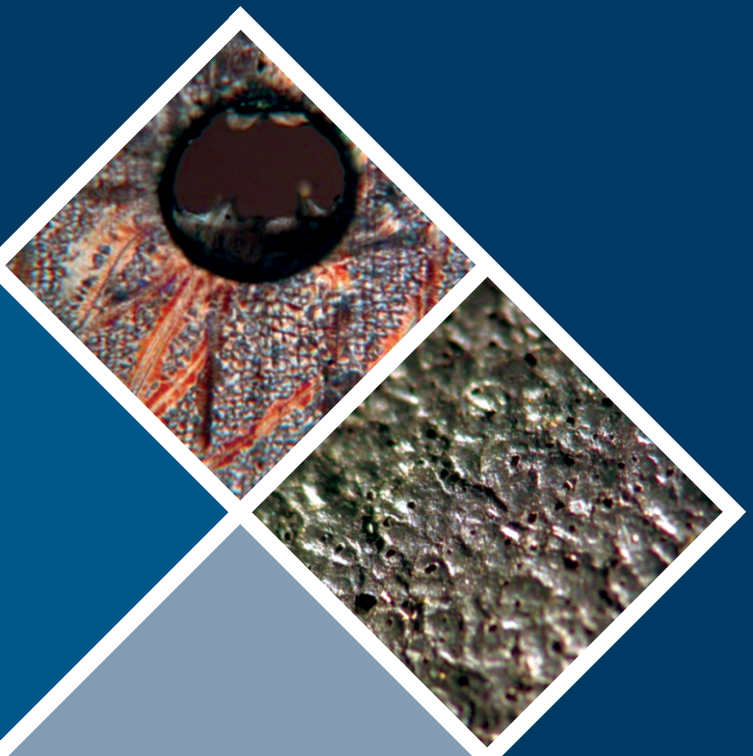

SASOL CHEMICALS

Rotational Moulding
Problem Solving Guide

Overview

SASOL AT A GLANCE

Sasol is an international integrated chemicals and energy company that leverages technologies and the expertise of our 30 400 people working in 36 countries. We develop and commercialise technologies, and build and operate world-scale facilities to produce a range of high-value product streams, including liquid fuels, chemicals and low-carbon electricity.

SASOL CHEMICALS

Sasol Chemicals is a producer and marketer of a range of commodity chemicals based on the Fischer Tropsch (FT) and natural gas value chains including chemical feedstocks of ethane, ethylene, propylene and ammonia. Final products include polymers, explosives, fertilisers, mining reagents (caustic soda, sodium cyanide), and a range of alcohols, ketones, acrylate monomers, and other oxygenated solvents.

Final products marketed through the Polymers division include low density polyethylene (LDPE), hexene linear low density polyethylene (hLLDPE), polypropylene (PP), and polyvinyl chloride (PVC) as well as propylene and ethylene monomers. Through this product portfolio we offer polymer solutions for a broad range of applications and industries.

Our polymers are marketed throughout Sub-Saharan Africa, Europe, Americas and Asia and we are active in over 75 countries globally.

Our Polymer Technology Services Centre in Johannesburg provides expertise and technical service support to external customers and also undertakes polymer-related applications research and development applicable to the Polymers division.

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Problem solving guide

Warped parts

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
1. Warped parts	Inadequate venting	Provide adequate venting (10mm to 12mm diameter vent per 28.5 litres of mould volume is suggested for thin walled parts)	Resin type	Use proper resin having adequate melt index and molecular weight distribution for application
	Non uniform cooling of the part caused by resin pulling away from the mould wall	Rotate mould during cooling cycle. Provide adequate venting and make sure the vents are not blocked. Use less mould release Check for too effective a mould release agent. Avoid large flat panels in part design if possible. Reduce cooling rate during the initial part of the cooling cycle Increase the temperature of the cooling medium - air cool then water cool. Apply air pressure through the spindle during cooling	Moisture in resin or pigment	Only use dry powder and/or pigment
	Non uniform cooling caused by uneven wall thickness in part	See suggested remedies under problem "Uneven wall thickness of moulded parts"		
	Non uniform cooling caused by sections of the mould being shielded from heat and cooling medium.	Mount the mould to eliminate shielding problem. Add baffles to direct heat and cooling into recessed or shielded areas.		
	Uneven cooling caused by clogged water nozzles	Check and clean nozzles on a periodic schedule		

Warped parts

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
	Over-cured part. Degradation of the resin due to high temperature and/or excessively long heating cycles	Decrease oven temperature or heating cycle		
	Highly under-fused part. Some degree of under-fusion is desirable especially in the case of low melt index resins to prevent degradation; however, highly under-fused parts can cause significant loss in impact strength.	Increase oven temperature or total heating cycle. Increase heat transfer rate by using thinner mould walls, or make the mould from materials with greater heat transfer coefficients e.g. steel or aluminium.		
	Improper colouring	Select pigments and pigment loading which does not affect resin. Use pre-coloured compounded resins		

Poor impact strength

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
2. Poor impact strength	Density increase during slow cooling	Increase the cooling rate to maintain a lower density	Resin selection not correct.	Use a lower density or lower melt index resin.
	Part design not appropriate	Review and alter mould design if necessary, eliminating sharp corners and narrow passages.	Incorrect colouring.	Select pigment and pigment loading that does not affect impact strength.
	Insufficient fusion of resin.	Increase oven time and/or oven temperature.		
	Over-curing of resin. Degradation of resin due to long term high temperature.	Decrease oven temperature or heating cycle.		

Parts stick in mould

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
3. Parts stick in mould	Insufficient amount of mould release agent, or the mould release has deteriorated with use.	Re-apply or use more mould release. Old release may have to be removed before applying a new coating.		
	Ineffective mould release agent, or mould release which does not withstand elevated temperatures.	Use suitable mould release agent that is effective for resin and temperature used; apply according to suppliers instructions.		
	Interference during part removal.	Locate mould parting line at undercut, or taper side wall of mould.		
	Roughness and porosity of mould surface provide areas where resin may stick.	Refinish damaged mould surfaces (plug, weld or sand smooth).		
	Presence of resin at parting line due to internal mould pressures, which tends to force semi-molten resin through parting line.	Provide adequate venting (10mm-12mm diameter vent per 28.5 litres of mould volume is suggested for thin walled parts).		
	Build-up of degraded resin in the mould may be caused by burning of thin walled sections.	Clean the mould periodically.	Low shrinkage value for resin	Use a higher density resin
	Shrinking into large deep seated areas.	Provide adequate taper to mould walls. Use very effective mould release on insert area. Remove part while warm. Provide adequate means for applying force to separate mould halves.		
	Undercuts in mould.	Design mould to place undercut at parting line so that the mould has a draft angle for part removal.		

Blow holes

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
4. Blow holes through part or ringworm effect under the part wall surface other than at parting line	Porosity in cast aluminium mould.	Obtain better quality castings. Drill through void and drive in pin or weld from inside.		
		Relieve from outside by drilling into void. Remove parts from mould whilst mould is still warm. This helps to drive moisture out of the pores.		
	Pores or holes on welds.	Use proper welding rod and procedure. Weld inside surface first to get good penetration.		

Bubbles on the mould parting line

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
5. Bubbles on the mould parting line	During the first stages of cooling there will be a rush of air into the part to fill the resultant partial vacuum. If there is inadequate venting, air will penetrate the molten resin at the parting line and become trapped as the part wall solidifies.	Vent the mould to atmospheric pressure. Relocate vent to middle of mould. Use glass wool in the vent. Use Teflon as a vent tube. Make sure the vent is the correct size.		
	Poor mould parting line.	Re-mate the mould parting line and adjust mould clamp pressure evenly. Clean mould flanges to prevent gapping and apply new mould release on flange.		

Blow holes

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
6. Blow holes through part around inserts	Poor fit on inserts allowing moisture or vapours to be trapped around insert and expand, blowing a hole in the part.	Refit inserts and relieve to allow trapped gases to escape. Drill a small hole through the insert bolt to relieve gas pressure.		
	Bridging of resin because of close dimensions	Change insert dimensions or location to allow powder to flow without bridging.		

Excessive flashing

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
7. Excessive flashing at mould parting line	Internal mould pressure during heating cycle tends to force semi-molten resin through the parting line.	Provide adequate venting and ensure the vents are not blocked. Re-mate mould parting line and adjust mould clamp pressure evenly. Clean mould flange to prevent gapping and apply new mould release on flange. Reduce internal air pressure if used.	Melt index of resin may be too high	Use lower melt index resin

Discolouration of interior surface of part

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
8. Discolouration of interior surface of part	Degradation of resin due to high temperature and/or excessively long heating cycle.	Decrease oven temperature/ oven time, or purge part with inert gas (nitrogen)	Resin selection incorrect	Use resin with the proper amount and type of antioxidant. Check pigment for heat stability.

Powder bridging

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
9. Powder bridging or not filling parts of mould	Mould design incorrect.	Modify mould by increasing width to depth ratios across the mould opening. Design corners of the mould with more generous radii. Avoid ribs with less than 4 x wall thickness.	Poor dry flow of powder Powder does not melt or flow properly.	Make sure powder has acceptable dry flow and bulk density. Use a finer mesh powder or a resin with a higher melt index.
	Cold spots on mould	Avoid any shielded mould areas. Check for mould wall thickness uniformity.		
	Improper mould rotation	Use correct ratio and rotation speeds.		

Poor part stiffness

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
10. Poor part stiffness	Part wall too thin	Add more powder to the initial charge	Resin selection not correct	Use a resin with a higher density.
	Part design not correct	Review and alter mould design if necessary.		
	Under-fused part	Increase oven temperature or total heating cycle. Increase heat transfer rate by using thinner mould walls or make the mould from a material with a greater heat transfer coefficient. Try filling the moulds while hot.		

Lightening effect in coloured parts

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
11. "Lightening" effect in coloured parts	Static build up	Make sure that all mixing and moulding equipment is adequately grounded with high surface copper cable.		Add a small amount of mineral oil to resin or commercially available antistatic additive.
			Moisture in pigment or resin	If dry blending, dry pigment, or use pigment from unopened containers. Dry resin completely or replace.
			Pigment not ground properly	Use 100 mesh pigment, or pulverise prior to mixing. Use pre-compounded colours.

Speckled colours

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
12. Speckled colours and lumps of pigment in dry blended colours			Insufficient blending of powder with pigment	Break up agglomerates of pigment before blending. Use high speed intensity mixer. If unable to achieve a desirable colour balance, use compounded colour.

Long oven cycles

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
13. Long oven cycles	Heat transfer rate not adequate to melt all the resin. Excessively thick mould	Increase heat transfer rate by using thinner mould walls, or make the mould from a material with a greater heat transfer coefficient.	Resin powder too coarse.	Use a finer mesh powder.
	Heating not efficient	Increase air velocity around mould during heating cycle. Check oven for air leaks.	Poor flow	Use a higher melt index resin
	Low oven temperature	Increase oven temperature. Recalibrate instruments on a regular basis.		
	Extended cooling	Reduce air-water cooling ratio.		

Long term part failure

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
14. Long term part failure	Part overcured during moulding	Decrease oven temperature or heating cycle	Photodegra-dation of part caused by ultra violet light from sun or internal fluorescent lighting.	Use a UV stabilised resin in the application. Add a suitable UV stabiliser and/or pigment. A fine well dispersed carbon black compounded into the resin offers good UV protection.
	Stress cracking due to multiaxial stresses in the part; may have been accelerated by chemical environment and temperature	Use a stress crack resistant polyethylene grade. Do not store an environmental stress solution in a container moulded from a poor ESCR grade of polyethylene for a long period of time, or at elevated temperatures. Modify design around the area containing inserts. Examine part in field use to determine adequacy of design around stress concentration points.	Inadequate resin additive system	Antioxidant type and/or concentration may be inadequate. Reduce level of internal mould release if used.
	Colour changes due to oxidation	Reduce oven residence time		

Uneven thickness

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
15. Uneven thickness of moulded part	Incorrect mould rotation	Vary ratio and speed of mould rotation to obtain even coverage and adequate number of powder trackings.	Poor powder properties. Low bulk density and high flow, large amount of fluff, or particles, which entangle into clumps when moulding.	Obtain an acceptable powder.
	Mould shielded	Mount mould to eliminate shielding		
	Uneven mould wall thickness	Use care in designing moulds to prevent excessive variations in mould wall thickness.		
	Buffeting or air flow in deep draw areas	Avoid deep draw areas if possible. Open handles so that air can flow through kiss-offs in mould.		

Highly undercured part

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
16. Highly undercured part with many small bubbles in wall, or powdery inside surface	Oven temperature not high enough to remove air bubbles from part wall	Increase oven temperature or total heating cycle.	Moisture in powder	Obtain an acceptable powder
	Heat transfer rate not adequate to melt all the resin properly	Increase heat transfer rate by using thinner mould walls, or make mould from material with greater heat transfer coefficient	Resin powder too coarse	Use a finer mesh powder
	Moisture in mould	Reduce moisture in mould by running with warm moulds and dry mould before charging with powder		

Poor flow

Fault description	Causes associated with process/ equipment	Possible solution	Causes associated with raw materials	Possible solution
17. Poor flow into mould recesses	Poor mould design	Design shallow recesses with generous radii on edges. Pre heat recessed areas before charging. Add heat deflectors or thermal pins	Melt index of resin too low	Use a higher melt index resin
	Improper mould rotation	Change rotation ratio and/or rotation speeds.		