

TOYOLACTM
Post-Consumer Recycled-PC//ABS
Halogen Free Flame Retardant Alloy Grade

TECHNICAL GUIDE

Toray Plastics (Malaysia) Sdn. Bhd.
Penang (Head Office)
2628 MK1, SPT., Lorong Perusahaan 4,
Prai Free Industrial Zone,
13600 Prai, Penang, Malaysia.
TEL:+60-4-3988088
FAX:+60-4-390897

1.0 INTRODUCTION

TOYOLAC™ Post-Consumer Recycled PC//ABS alloy is a newly developed specialty r-PC//ABS (Recycled-PC//ABS) alloy series by Toray Industries, Inc. to meet the market requirement for high performance green material. In conjunction with the global concern of environmental issue towards greener environment, TOYOLAC™ Post-Consumer Recycled PC//ABS alloys are further designed with non-halogenated flame retarding system with wide-ranging levels of flammability and contents of post-consumer recycled polycarbonate.

TOYOLAC™ Post-Consumer Recycled PC//ABS alloy remains the basic physical and mechanical properties that is comparable to virgin PC//ABS with good impact strength, good flowability as well as excellent flame retardancy level, as listed below:

PRODUCT LINE-UP OF TOYOLAC™ POST-CONSUMER RECYCLED PC//ABS ALLOY

Typical Properties	Test Method	Test Conditions	Unit	TOYOLAC™ RNx84 X01	TOYOLAC™ RNx86-X01	TOYOLAC™ RNx87-X01	TOYOLAC™ RNx87-X03
Physical Properties							
Density	ISO 1183	23°C	kg/m ³	1180	1170	1165	1140
Melt Flow Rate	ISO 1133	240°C, 10kg	g/10min	40	60	55	33
Mechanical Properties							
Charpy Impact Strength, Notched	ISO 179/1eA	23°C/50%RH	kJ/m ²	43	18	43	45
Tensile Strength	ISO 527	50 mm/min	MPa	62	58	55	50
Tensile Elongation at Break			%	>30	>10	>10	>10
Tensile Modulus		1 mm/min	MPa	2600	2400	2500	2300
Flexural Strength	ISO 178	2 mm/min	MPa	92	90	88	80
Flexural Modulus				2400	2400	2300	2100
Thermal Properties							
Deflection Temperature under Load	ISO 75	1.8MPa, Unannealed	°C	84	82	80	80
Flammability							
Flammability	UL 94	File No.: E41797	-	1.5mm V-0	1.5mm V-0 1.5mm 5VB	1.2mm V-1	1.5mm V-1 2.5mm V-0

2.0 PROCESSING CONDITIONS

2.1 PRE-DRYING

Generally, TOYOLAC™ Post-Consumer Recycled PC//ABS alloy is hygroscopic and absorbs moisture in proportion to the environmental humidity. The absorption process of moisture is reversible process, and therefore moisture can be removed from the wet pellets in the environmental air with low humidity. Reversibly, dried pellet could absorb moisture until achieving an equilibrium moisture content with the moisture in the air. The exact amount of moisture content depends on the environmental relative humidity and exposure duration of the resin.

Upon exposing r-PC//ABS resin to humidity, the moisture is adsorbed onto the surface and absorbed into the pellets itself. Typical equilibrium moisture content of TOYOLAC™ Post-Consumer Recycled PC//ABS alloy resin at 23°/50%RH is ranging between 0.2 to 0.3%, at 40°/95%RH ranging between 0.5 to 0.6%. The absorbed rate of moisture is depending on pellet size and environmental temperature.

Direct processing with undried r-PC//ABS resin could cause silver streaking defects on the molded articles as well as occurrence of hydrolysis which result in poor impact strength. Hence, for TOYOLAC™ Post-Consumer Recycled PC//ABS alloy resin, the recommended moisture level prior to molding is less than 0.1%, and more desirable is 0.05%.

Typical pre-drying temperature and duration of TOYOLAC™ Post-Consumer Recycled PC//ABS alloy resin by using oven with internal air circulation are shown as follows:

Drying Temperature: 75 ~ 85 °C
Drying Time: 3 ~ 5 hrs

2.2 INJECTION TEMPERATURE, PRESSURE & SPEED

Injection molding conditions should be properly controlled according to the molding machine, the shape and size of the product, and the mold structure. Typical molding conditions are as below:

Melt temperature of polymer	: 240 ~ 265°C
Injection pressure	: 70 ~ 140 MPa
Mold temperature	: 30 ~ 60°C
Screw rotating speed	: 30 ~ 70 rpm

Temperature in excess of above recommended could result in discoloration or burn marks problems. These are the sign of material degradation. In addition, it could also result in generating noxious and corrosive vapors which could cause mold and equipment corrosion. Melt temperature of resin should be controlled between 240°C and 265°C. The mechanism of degradation is time or temperature effective and involves total heat history of the resin.

These excess heats could be controlled by gate and land dimension, slower injection rate or lower injection pressure. In case of accidental thermal degradation, noxious and corrosive gas may be generated. Thus, the barrel shall be purged, followed by shutting off the machine, and quenching the purge shot in water. *Please refer to subsection of "Purging" for more information.*

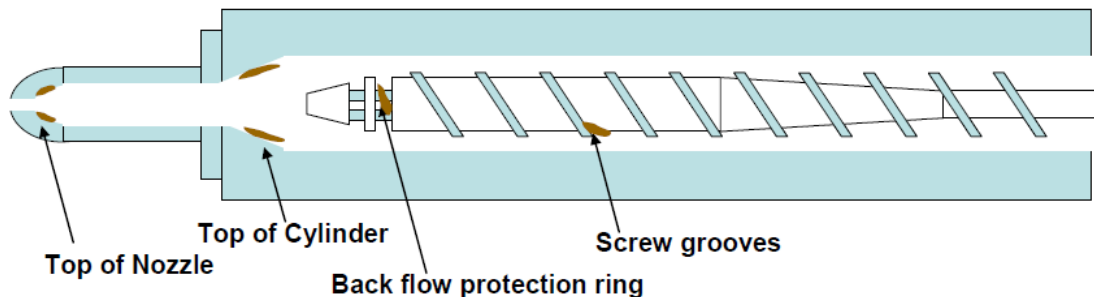
Even though cylinder temperature of injection molding machine is controlling within the recommended temperature range, longer residence time might induce thermal degradation, thereby generating carbonized materials.

The mold temperature affects the surface quality and the level of residual stress in the molded products. To provide molded product having excellent surface finish and minimal residual stress, the mold temperature should be controlled as high as possible, ranging between 30°C ~ 60°C. However, higher mold temperature may cause longer cycle time and warpage problem. Hence, extra precautions shall be taken by applying excessive mold temperature.

Injection speeds depends on products shape, gate structure and runner dimensions. Moderate injection speed is preferable to prevent orientation of rubber particles due to excessive shear. Injection pressure should be controlled to mold the articles consistently with acceptable quality. Various parameters affect injection pressure, such as injection temperature, products shape, nozzle and gate size, runner dimensions and mold temperature. Typical injection pressure range is 70 ~ 140MPa. It is crucial that injection pressure should drop off to holding pressure after fill-up immediately.

2.3 PURGING

Purging operation should be required if carbonized material is generated during continuous molding operation. Equipment cleaning should include frequent purging with natural color ABS resin or AS resin. In case of carbonized material does not stop generating even though purging operation has been carried out sufficiently, screw should be taken out and remove carbonized materials that are stuck on screw surface, screw grooves, top of nozzle and cylinder should be cleaned up.



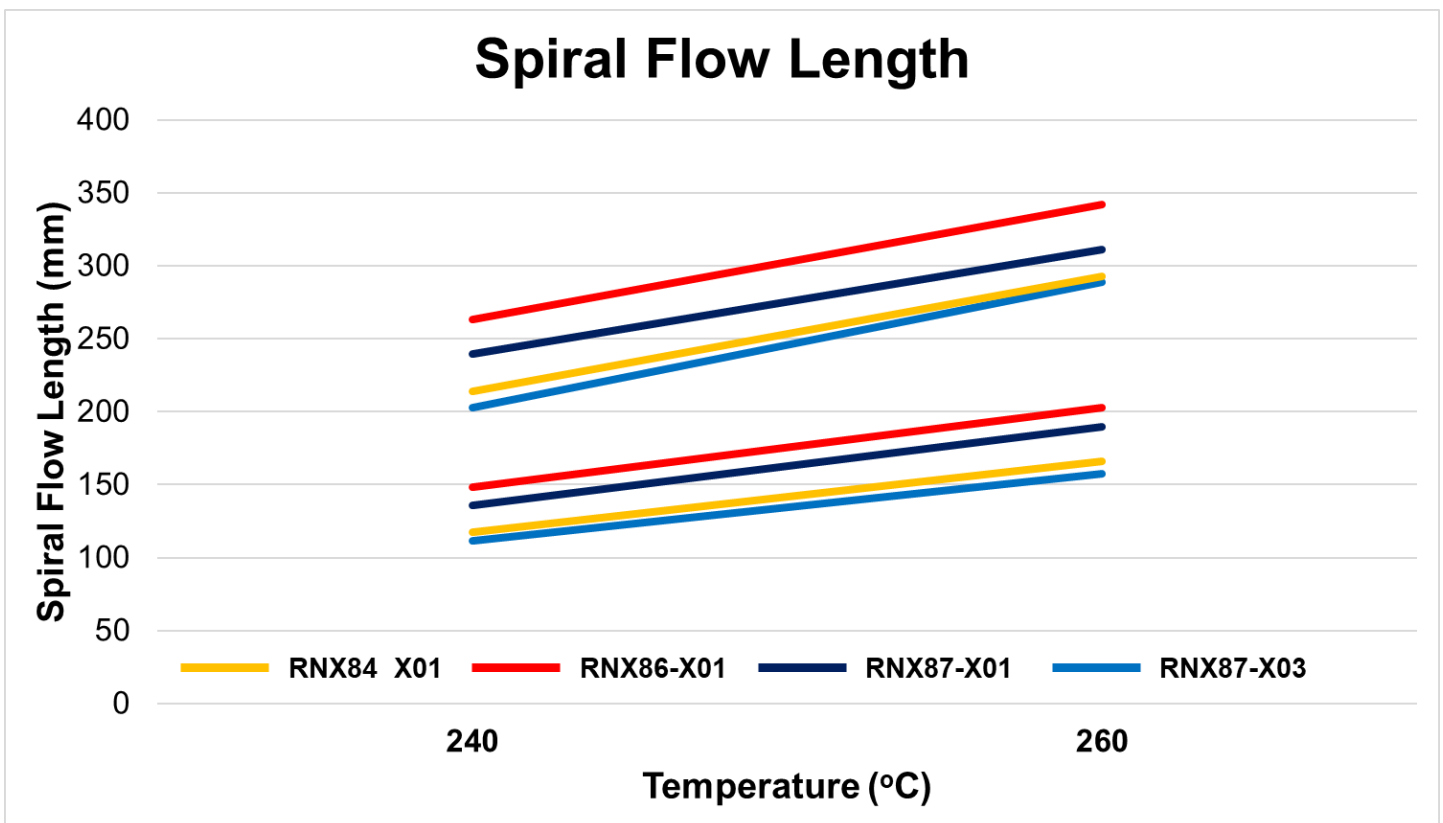
If machine shutdown is required, the material shall be removed from the machine and subsequently purge with natural ABS resin (or AS resin) or proper screw cleaning agent for avoiding from material degradation and the corrosion of equipment. In case of molding operation is resumed after shutdown, purging operation should also be required to ensure the purge materials are free of carbonized material.

3.0 SPIRAL FLOW LENGTH

TOYOLAC™ Post-Consumer Recycled PC//ABS alloy resin is developed with wide-ranging flowability properties to suit numerous processing and application requirements, in which determined as Spiral Flow Length as shown in the figure below as a function of the melt temperatures with injection pressures as parameters.

Molding Condition:

Molding Machine	: Toshiba Machinery, IS80A
Melt Temperature	: 240, 260°C
Mold Temperature	: 60°C
Injection Pressure	: 50, 100 MPa
Injection Speed	: Medium (FCV B-0: Fill-in Time 2 sec.)
Mold Dimension	: 10W x 2 mm ^t (Spiral Flow)



4.0 MOLD SHRINKAGE

Grades	Melt Temperature / Mold Temperature (°C)	Holding Pressure	Shrinkage Rate (%)			Range (%)
			Transverse Direction		Machine Direction	
			A – A	B – B	C – C	
TOYOLAC™ RNX84 X01	250°C/60°C	Min. Pressure + 5 MPa	0.47	0.50	0.50	0.4 ~ 0.7
		Min. Pressure + 10 MPa	0.40	0.42	0.40	
TOYOLAC™ RNX86-X01		Min. Pressure + 5 MPa	0.49	0.55	0.42	
		Min. Pressure + 10 MPa	0.47	0.51	0.39	
TOYOLAC™ RNX87-X01		Min. Pressure + 5 MPa	0.64	0.71	0.58	
		Min. Pressure + 10 MPa	0.58	0.69	0.54	
TOYOLAC™ RNX87-X03		Min. Pressure + 5 MPa	0.67	0.72	0.60	
		Min. Pressure + 10 MPa	0.60	0.64	0.55	
TOYOLAC™ 700 314	230°C/60°C	Min. Pressure + 5 MPa	0.54	0.54	0.59	0.4 ~ 0.6
		Min. Pressure + 10 MPa	0.49	0.48	0.55	

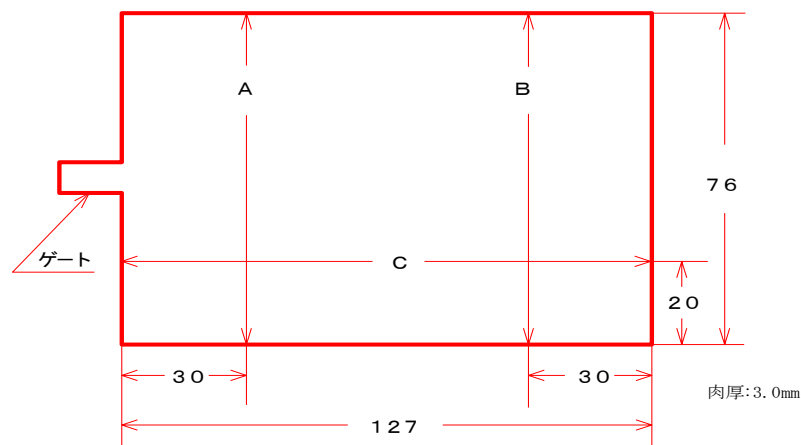
Molding Condition

Molding Machine : NISSEI ES4000

Mold Dimension : 127 x 76 x 3 mm^t

Shrinkage Measurement Method

Dimensional measurement of test specimens was conducted after conditioning at 23°C/50%RH for 24 hours



5.0 TROUBLESHOOTING GUIDE

Typical molding problems and recommended remedies are shown in the following table. Typical cause of molding defects is the tangle of any kind of factors such as improper molding conditions, imperfect design of mold tooling and molded articles. Any one of the suggested remedies may solve a particular problem. However, some problems may require a combination of suggested remedies.

Problems Remedy	Short Shots	Flash	Sink Marks	Burn Marks	Poor Weld Line	Low Gloss	Jetting	Excessive Warpage	Scratches	Air Marks	Silver Streaking	Crack, Whitening
Increase Injection Speed	✓		✓		✓	✓		✓				✓
Decrease Injection Speed				✓			✓			✓	✓	
Increase Injection Pressure	✓		✓		✓				✓			
Decrease Injection Pressure		✓		✓				✓			✓	✓
Increase Mold Temperature	✓				✓	✓	✓				✓	✓
Decrease Mold Temperature			✓					✓	✓			
Increase Barrel Temperature	✓				✓	✓	✓	✓				✓
Decrease Barrel Temperature		✓	✓	✓					✓		✓	
Decrease Nozzle Temperature				✓								
Increase Nozzle Temperature					✓	✓						
Check Nozzle, Sprue, Runner & Gate Size	✓		✓	✓			✓		✓		✓	✓
Check Gate Position & Number	✓				✓		✓		✓		✓	
Improve Venting	✓			✓	✓	✓				✓	✓	
Increase Filling Quantity	✓		✓						✓			
Decrease Filling Quantity		✓										
Check Clamping Force		✓										
Increase Holding Pressure						✓						
Decrease Holding Pressure		✓						✓				✓
Increase Holding Pressure Time			✓			✓						
Decrease Holding Pressure Time		✓						✓				✓
Increase Cooling Time			✓						✓			
Decrease Screw r.p.m.											✓	
Check Pellet Drying											✓	

Table 1: Troubleshooting Guide for TOYOLAC™ r-PC//ABS Alloy Resin

Important Notes:

1. In as much as Toray Plastics (Malaysia) Sdn. Bhd. has no control over the use to which other may put this material, it does not guarantee that the same result as those described herein will be obtained. Nor does Toray Plastics (Malaysia) Sdn. Bhd. guarantee the effectiveness or safety of any possible or suggested design for articles of manufacturer as illustrated herein by any photographs, technical drawing and the like. Each user of the material or design or both should make his own tests to determine the suitability of the material or any material for the design, as well as suitability or suggested uses of the material or design described herein are not to be construed as constituting a license under any Toray Plastics (Malaysia) Sdn. Bhd. patent covering such use or as recommendations for use of such material or design in infringement of any patent.
2. The material described here is not recommended for medical application involving any implantation inside the human body. Material Safety Data Sheet (MSDS) for the materials concerned should be referred to before any use.