

**“TOYOLAC” RFX10-X01  
ABS// Post Consumer Recycled- PET  
Alloy Grade**

*Technical Guide  
For  
Processing & Molding*

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**DRAFT**

## 1. Introduction

“TOYOLAC” RFX10-X01 is a newly developed of specialty ABS//Recycled-PET by Toray Industries, Inc. to meet the market requirement in term of mechanical properties, physical properties also aesthetic appearance improvement. In conjunction with the global concern of environmental issue towards greener environment.

“TOYOLAC” RFX10-X01, it remains the basic physical and mechanical properties comparable to virgin ABS with good impact strength and chemical resistance.

### Typical Mechanical Properties of “TOYOLAC” RFX10-X01

Property 代表物性	Test Method 试验法	Test Conditions 试验条件	Unit 单位	TOYOLAC RFX10 X01
<b>Physical Properties 物理性能</b>				
Density 比重	ISO 1183	23°C	kg/m <sup>3</sup>	1110
Melt Flow Rate 流动系数	ISO 1133	260°C, 5 kg	g / 10min	25
<b>Mechanical Properties 机械性能</b>				
Charpy Impact, Notched 缺口冲击强度	ISO 179/1eA	23°C / 50% RH	kJ/m <sup>2</sup>	20
Tensile Strength 引张强度;降伏点	ISO 527	50 mm/min	MPa	50
Tensile Elongation at Break 拉伸伸长率		50 mm/min	%	16
Tensile Modulus 拉伸模数		1 mm/min	MPa	-
Flexural Strength 弯曲强度	ISO 178	2 mm/min	MPa	68
Flexural Modulus 弯曲模数				2000
<b>Thermal Properties 热性能</b>				
Deflection Temperature under load 热变形温度	ISO 75	1.8 Mpa / 120°C/hr	°C	76
<b>Flammability 燃烧性</b>				
Flammability 燃烧性	UL 94	-	-	HB

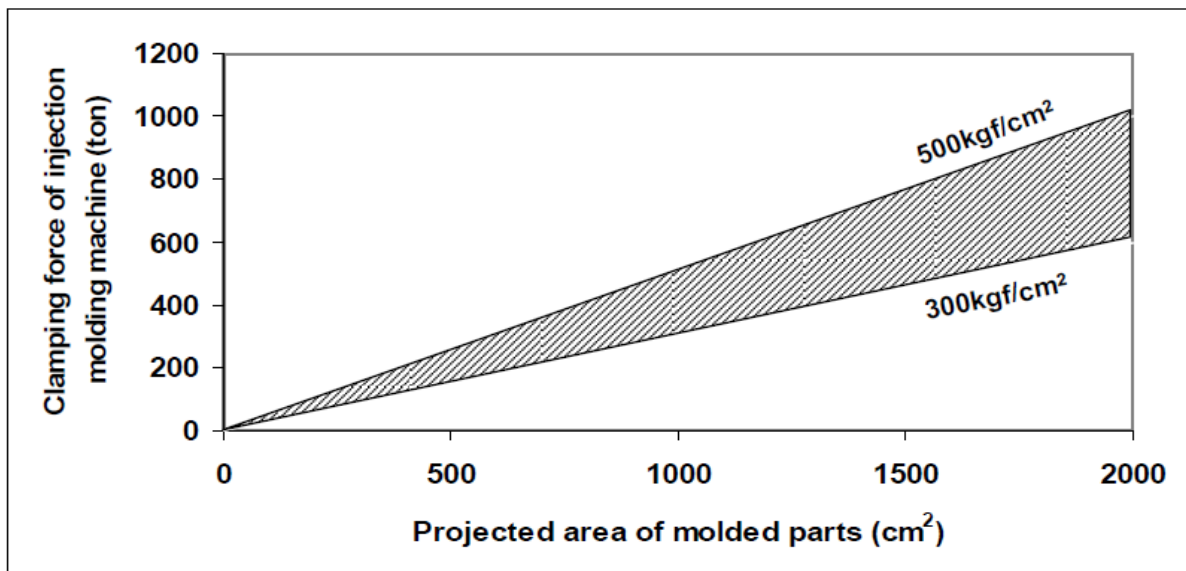
## 2. Processing & Molding Conditions

### 2.1 Injection molding machine

- Clamping force of injection molding machine should be calculated as below mentioned formula (pressure in cavity of ABS resin is generally around 300-500 kgf/cm<sup>2</sup>), and refer to below relation graph. Appropriate injection molding machine should be used to match the mold size.

Clamping force (ton)

$$= \text{Projected area of molded parts (cm}^2\text{)} \times \text{pressure in cavity (kgf/cm}^2\text{)} \div 1000$$



- Shot volume of injection molding machine is recommended around 70-90%. It's suitable for following below mentioned formula. In case of less than 50% shot volume, residence time of material inside cylinder should be longer. That situation causes discoloration and deterioration of mechanical property.

$\text{Shot volume of injection molding machine} > \text{Weight of molded parts} \div \text{Specific}$
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- Screw type of injection molding machine should be recommended full-fright type (compression ratio 2.0~2.5). There is a possibility that using of high compression ratio type and high kneading type cause burning and discoloration defects.

## **2.2 Molding conditions**

### **2.2.1 Pre-Drying**

Generally, "TOYOLAC" RFX10-X01 resin is hygroscopic and absorbs moisture in proportion to the environmental humidity. The absorption process of moisture is reversible process; therefore moisture from wet pellet can be removed to environment with low humidity. Dried pellet should absorb moisture until the content reaches equilibrium moisture in the air. The exact amount of moisture content depends on the relative humidity and the period of exposure.

Processing of un-dried ABS resin can cause silver streak problem on molding also hydrolysis problem which will cause low impact strength. For ABS// Recycled- PET grades of "TOYOLAC" the suggested moisture level for molding is less than 0.1%, more desirable is 0.05%.

Typical drying temperature and time of "TOYOLAC" by using oven with internal air circulation are shown as follows;

Drying Temperature: 95~105°C

Drying Time : 3~5 hrs

### **2.2.2 Injection molding temperature and pressure**

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 as below:

Melt temperature of polymer : 240 ~ 260 °C

Injection pressure : 70 ~ 140 MPa

Mold temperature : 30 ~ 60 °C

Screw rotating speed : 30 ~ 70 r. p. m.

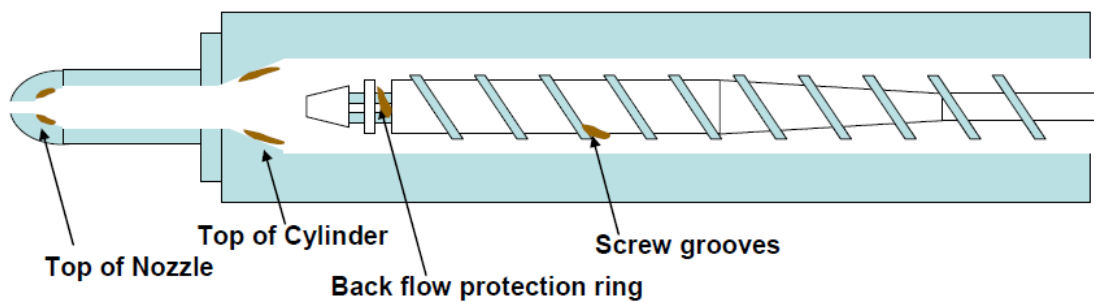
It should be properly controlled according to the injection moulding machine, the shapes and size of the product, and the mould structure. Temperature in excess of above recommended range could cause the burn mark problem. That trouble is a sign of damage to the material. Melt temperature of resin should be between 240°C and 260°C. It should be checked frequently and maintained within above recommended range to prevent defect of appearance and mechanical properties. If shutdown is required, remove the material from the machine and purge out completely to avoid burning problem.

This excess heat can be controlled by gate dimension, slower injection rate or lower injection pressure. In case of accidental thermal degradation, noxious and corrosive gas may be occurred. Purge the barrel, shut off machine, quench purge shot in water. Please refer to further information that is mentioned under the title “Purging”.

Even though cylinder temperature of injection molding machine is controlled at recommended temperature range, longer residence time may cause thermal degradation and carbonized materials can be generated.

### **2.2.3 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.

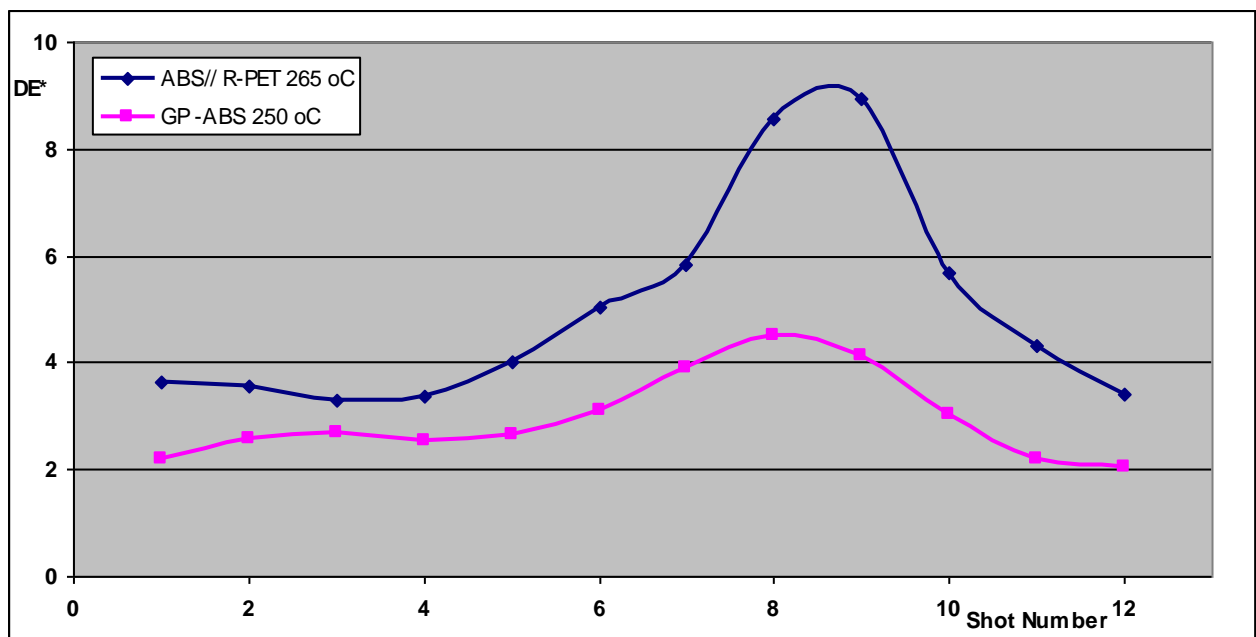


- If shut-down is required, remove the material from the machine and purge with natural ABS resin (or AS resin) or proper screw cleaning agent due to avoid the burning trouble and the corrosion of equipment.
- In case of molding operation is resumed after shut-down, purging operation should be required until carbonized material does not come out throughout

### 3. Heat Stability Test of “TOYOLAC” RFX10-X01 versus General Purpose GP ABS

Heat Stability test is Toray Plastics in-house test method to simulate the color stability of molten polymer inside the barrel after 30 minutes residual time with additional 20°C higher than recommended process temperature (GP ABS: 230 °C, ABS// R-PET: 245 °C).

Color stability of “TOYOLAC” RFX10-X01 is inferior as compared to GP ABS. Therefore, to avoid discoloration and thermal degradation problem, it is recommended shot volume of injection molding machine is recommended around 70 - 90%. In case of less than 50% shot volume, residence time of material inside cylinder should be longer. That situation causes discoloration and deterioration of mechanical property.



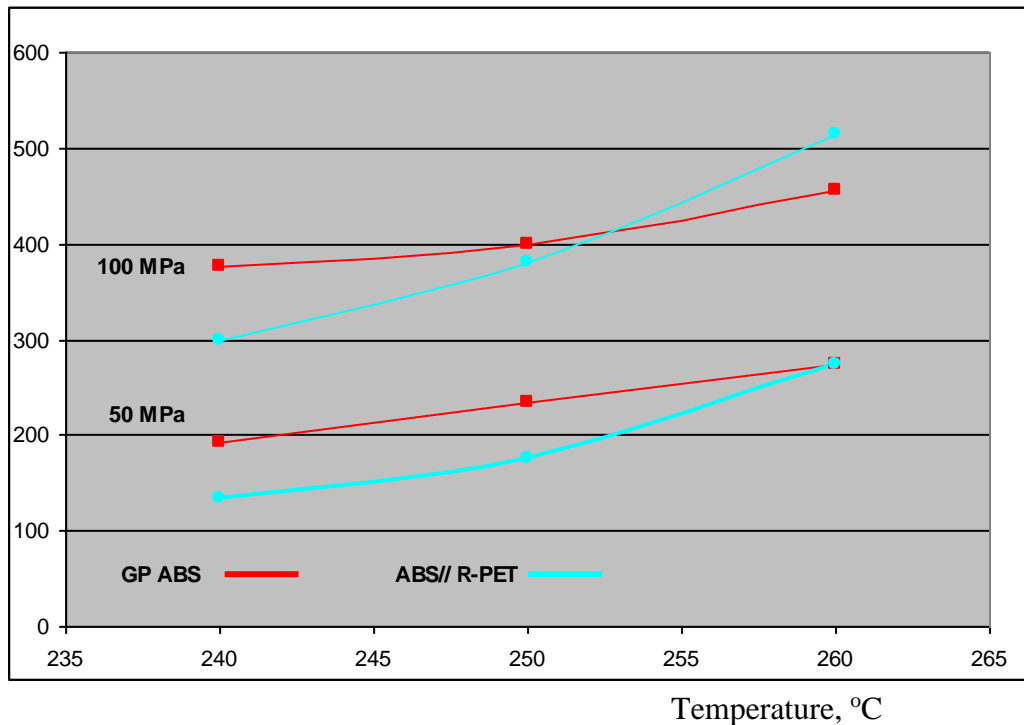
#### 4. Spiral Flow Length

“TOYOLAC” RFX10-X01 has excellent flow ability. The flow ability of “TOYOLAC” gives good flow behaviour as GP ABS in Spiral Flow Length, in figure below as a function of the injection temperature with injection pressure as parameter. It is useful for comparing the flow ability of products under the same conditions even if this test has not been standardised

##### ***Moulding Condition:***

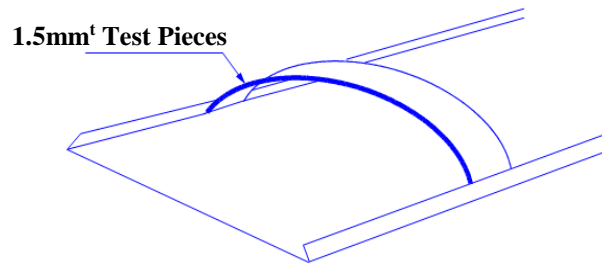
- a. Moulding Machine : Toshiba Machinery, IS80A
- b. Moulding Temperature : 240, 250, 260°C
- c. Mould Temperature : 60°C
- d. Injection Pressure : 50, 100 MPa
- e. Injection Speed : Medium (FCV B-0 : fill-in time 2 sec.)
- f. Mould Dimension : 10W×2mm<sup>t</sup> (Spiral Flow)

Length, mm



## 5. Environmental Stress Cracking and Crazing of TOYOLAC” RFX10-X01

“TOYOLAC” RFX10-X01 will undergo stress cracking and crazing when subjected to certain chemical environments under high stress for given periods of time. This cracking and crazing will occur even though some chemicals will have no effect on unstressed (relaxed) parts, and therefore simple immersion of test pieces is an inadequate measure of chemical resistance of the polymer. There are two cases of stress generation. One is caused by external force (external stress), another is the stress that remains in moulded parts (residual stress). Residual stress in moulding parts is generated by uneven cooling speed and fluctuation of melt flow during moulding. Residual stress relaxes gradually with time. However, degradation is accelerated by having contact with a chemical agent. It may cause cracking and crazing trouble. These phenomena are so called "Environmental Stress Cracking and Crazing (ESC)". Cracking phenomenon is observed on moulding surface when it is soaked in a chemical agent under applied stress.



$$\delta(\%) = \frac{\pi^2 2 \sqrt{l' \times (l - l')}}{l'^2 \times \pi} \times \frac{t}{2} \times 100$$

$l$  : Test Pieces Length = 127 mm

$l'$  : Test Pieces Length = 98 mm

$\delta$  : Strain = 3%

$t$  : Test Pieces Thickness = 1.5 mm

**Judgment:**

**A- No Defect**

**B- Craze**

**C- Crack**

**D- Break**



<b>Chemical</b>	<b>General Purpose ABS</b>	<b>ABS// R- PET</b>
<i>Waxco - Auto Leather Care</i>	A	A
<i>KAO - Toilet Magiclean Bleach</i>	A	A
<i>Kiwi- Kleen Express Cleaner</i>	A	A
<i>Dettol- Antiseptic Germicide</i>	C	A
<i>Dettol- Hand Sanitizer</i>	B	A
<i>Ambi Pur- Febreze Fabric Refresher</i>	A	A
<i>Listerine- Antiseptic Mouthwash</i>	A	A
<i>Thinner</i>	C	A
<i>Methanol</i>	B	B
<i>Ethanol- 96%</i>	A	B
<i>Acetone</i>	C	C

## 6. Mold Shrinkage Rate

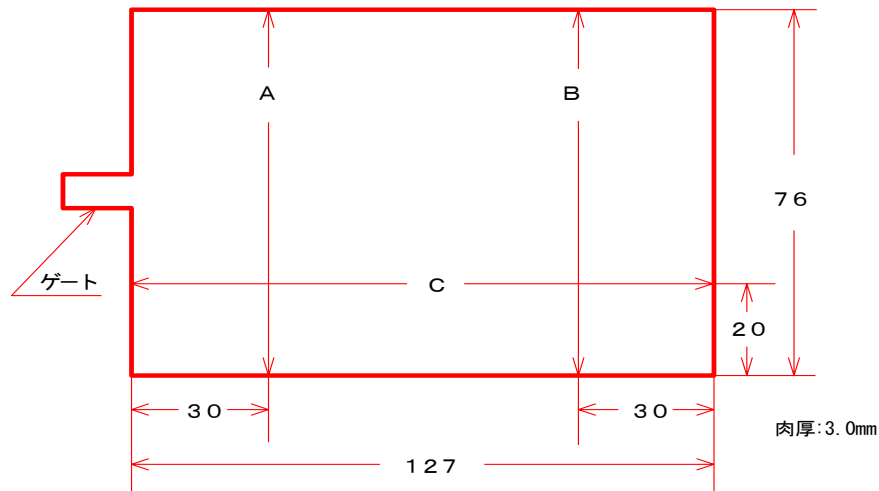
Grade	Molding temp/ Mold temp	Injection Pressure	Measuring Point		
			TD		MD
			A	B	C
"TOYOLAC" RFX10-X01	245 °C/ 50 °C	Min Pressure + 5%	0.61	0.76	0.71
		Min Pressure + 10%	0.59	0.67	0.68
"TOYOLAC" 700 X01 (GP ABS)	230 °C/ 50 °C	Min Pressure + 5%	0.59	0.72	0.70
		Min Pressure + 10%	0.56	0.65	0.66

### Molding condition

Molding machine : NISSEI PS60E-12A  
Molding temp : 245°C(ABS//R-PET), 230°C(700 X01)  
Mold temp : 50°C  
Injection pressure : Minimum pressure+10MPa  
※fill up by pressure control  
Mold measurement : 127 × 76 × 3mm<sup>t</sup>

### Dimension measurement

Measure test piece dimension after 24 hours remaining under 23°C, 50%RH



## 7. Troubleshooting

Typical molding problems and solutions are shown in Table 1. Particular molding problem may be caused by several factors such as improper molding conditions, imperfect design of mold and moldings. Any one of the suggested remedies may solve a particular problem. However some problems may require a combination of suggested remedies.

**Table 1. Checklist of Troubleshooting of “TOYOLAC” ABS resin**

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											✓	

Important Notes:

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