

**“TOYOLAC”**  
**Extrusion and Thermoforming Grade**

*Technical Guide*

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## 1.0 Introduction

TOYOLAC extrusion and thermoforming grade can be easily extruded in sheet, pipes or other various shaped sections using ordinary extrusion equipment.

### 1.1 Typical Mechanical Properties of “TOYOLAC” Extrusion and Thermoforming Grade

EXTRUSION GRADE					
Property 代表物性	Test Method 试验法	Test Condition 试验条件	Units 单位	Extrusion Thermoforming 押出热成型	Extrusion 押出
			Type 型号	600	600
			Suffix 区分字符	X50	X52
ISO STANDARD					
Melt Flow Rate 流动系数	ISO 1133	220°C / 10 kg	g/10min	6	5
Charpy Impact Strength (notched) 缺口冲击强度	ISO 179/1eA	23°C / 50 %RH	kJ/m <sup>2</sup>	30	23
Deflection Temperature Under Load 热变形温度	ISO 75	1.8 MPa / 120°C/hr	°C	82	82
Tensile Strength 引张强度;降伏点	ISO 527	50 mm/min	MPa	42	46
Tensile Elongation at Break 拉伸伸长率			%	>40	17
Tensile Modulus 拉伸模数			1 mm/min	MPa	2110
Flexural Strength 弯曲强度	ISO 178	2 mm/min	MPa	65	68
Flexural Modulus 弯曲模数				2080	2014
Density 比重	ISO 1183	23°C	kg/m <sup>3</sup>	1030	1040
Flammability 燃烧性	UL94 File No. E41797			HB	HB

Note: The above values are typical data for the products under specific test conditions and not intended for use as limiting specifications.

「以上数据谨代表在特定条件下所得的测定值的代表例」

## **2.0 Extrusion of Sheets**

### **2.1 Extrusion Machine**

As TOYOLAC has a slightly higher melt viscosity than high impact polystyrene, a slightly larger driving force is needed. A screw with a 20-22 L/D ratio is adequate, however, a 25-30 L/D ratio is recommended to achieve more uniform mixing and more constant output. Vent extrusion reduces the amount of pre-drying that is required and gives the sheets a well-finished appearance.

### **2.2 Screw**

It is recommended to use a constant pitch gradual transition flight type of screw with a compression ratio of 2.0-2.5. Full flight screw and torpedo head screw can also be used. The flight depth in the metering section should be a little deeper to avoid the generation of excessive heat that could result due to TOYOLAC's slight higher viscosity.

### **2.3 Sheet Die**

Either a T-shaped manifold or a coat hanger die can be used, however, a coat hanger die gives a smoother flow and less die line. A land length of 50 – 80mm is adequate. The opening of the die lips should be kept constant along the length of the die during extrusion, and the uniformity of the thickness should be adjusted using the choke bar and differences in temperature. Draw down of approximately 10% is appropriate for operation efficiency and orientation of the sheet.

### **2.4 Cooling**

A 3-roll, 8-inch diameter system made out of a hard chromium plate with a highly polished finish is adequate. The temperature of the cooling roll should be kept at a constant level to prevent the molten resin from sticking to the mold. If the temperature is too low, wrapping or sinking spot could result. Embossing, which required more accurate thickness and temperature controls, should be carried out with the embossing roll in the middle.

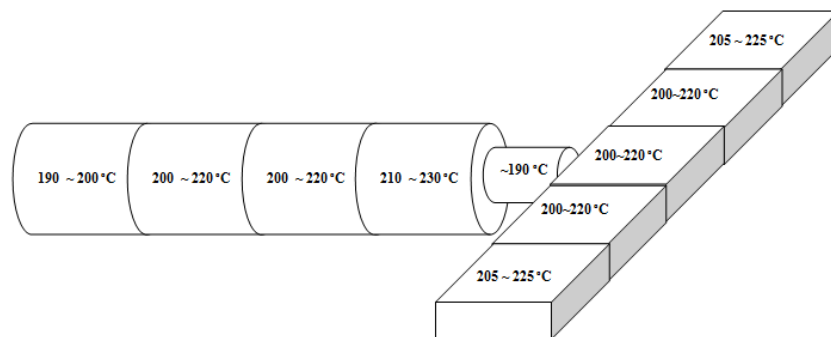
### **3.0 Pre-drying**

In order to obtain a good sheet having a fine surface finish, proper pre-drying is necessary. In sufficient drying will often result in poor surface finished such as porosity or die line, while proper drying will not only good surface but will increase and improve the constancy of the output. For drying a small amount of material, a tray oven will used. For large scale extruding of more than 100 kg/hr., a hopper dryer together with vent extruder will be necessary. Proper drying conditions are 4- 6 Hours at 80 °C or 3-4 Hours at 90 °C.

### **4.0 Extrusion Condition**

#### **4.1 Barrel Temperature and Die Temperature**

An example of typical extrusion condition are illustrated in Figure below



#### **4.2 Screen Pack**

Depending on application a 40/60/40 to a 80/100 x 2/80 mesh construction pack should be selected

#### **4.3 Cooling Roll Temperature**

Temperature should be as follows: for upper roll 80 – 105 °C, for middle roll 70 – 100 °C, for bottom roll 85 – 105 °C.

#### **4.4 Extrusion Condition and Mechanical Properties of the Sheet**

The mechanical properties of the extruder sheet are not affected if the extrusion is performed at 210- 240 °C of the barrel temperature. When the barrel temperature exceeds 240 °C, the impact strength and heat distortion temperature tend to decrease. For best result, the barrel temperature should be kept below 240 °C

## **5.0 Purging and Cleaning**

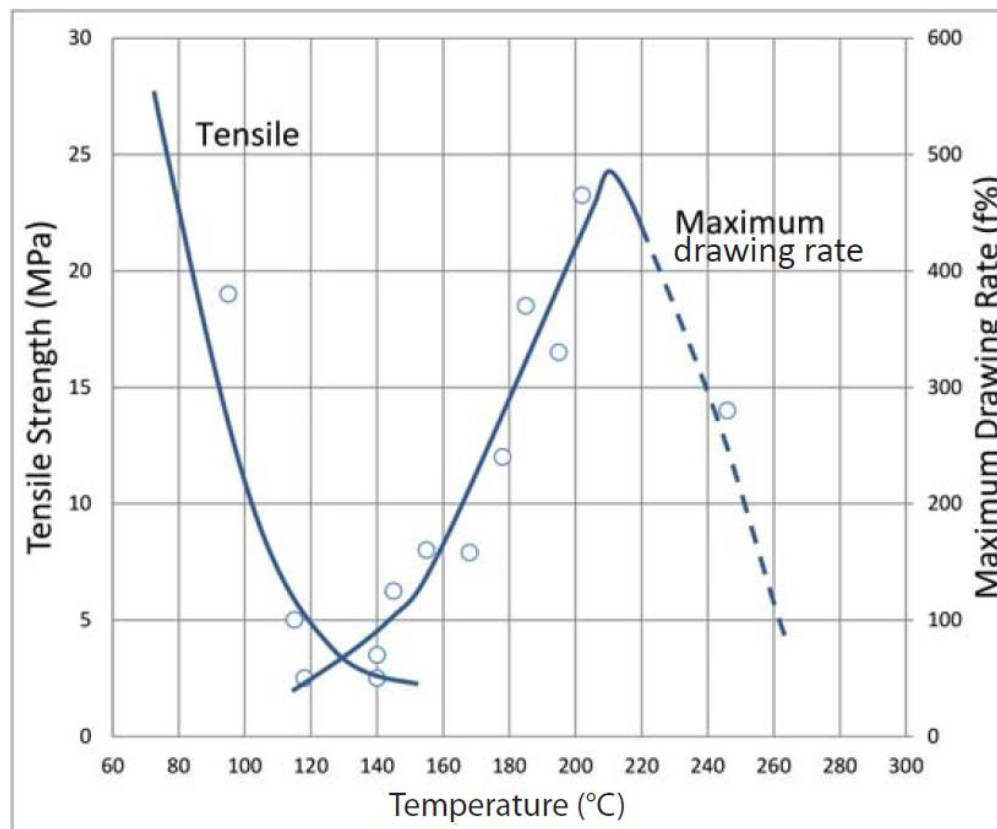
The die should be cleaned and any remaining resin should be tripped off after the die has cooled to approximately 150 °C. The screw can be easily cleaned by pulling it out from barrel and blowing with compressed air.

## **6.0 Vacuum Forming**

TOYOLAC sheet can be easily be vacuum formed into a variety of product including those with very complicated shapes which need drawing.

### **6.1 Temperature Dependence of the Sheet Characteristic**

Figure below indicates vacuum forming by showing the maximum draw ratio in relation to temperature and tensile strength in relation to temperature. Maximum draw was measured using Formvac Sheet tester. A can be seen from the figure below. A decrease in tensile strength at high temperature also indicated excellent vacuum formability.



## **6.2 Forming Process**

TOYOLAC Extrusion and Thermoforming grade can be formed easily by variety of vacuum forming process such as straight forming, drape forming, snap back forming, air slip forming, plug assist forming, and air cushion forming.

## **6.3 Forming Condition**

Forming is carried out most effectively at the temperature where the sheet exhibits maximum draw. Excess temperature will cause hang down, poor sheet appearance or an increase in heating cycle. Too low temperature will caused great residual stress in the molded part. It is important therefore, that an appropriate temperature be set in accordance with the machine, the gauge of the sheet or the mold shape. TOYOLAC Extrusion and Thermoforming grade is formed best at around 120 °C to 200 °C. Although the cooling period is closely related to the mold material, the sheet temperature and the gauge of the sheet, it is recommended that it be cooled until the sheet temperature reaches approximately 70 °C. With shallow draw forming, pre-drying is not necessary. When using heavy gauge sheet or complicated shape with deep draw, high temperature drying are preferable, 1-4 hours at 90 °C with normal dryer.

## **6.4 Mold Design**

When forming for TOYOLAC sheet, wood, plastics or metal can be used as the mold material. As the vacuum speed is determined by the diameter of the mold and the number of vacuum ports it has, these factor should be decided so that favorable forming time can be obtained in regard to the shape of the product and the forming characteristics of the sheet. It is preferable to use as large a radius of curvature as possible and sharp edge forming should be avoided. The amount of shrinkage depend on the shape or forming conditions as varies between 0.5 – 0.7%. A draft angle of 0.5- 1° for female mold, and 3- 4° for male mold are necessary. A mold temperature of 70 – 80 °C is recommended.

**Important Notes:**

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