Plastics Data File – PPO (Noryl™)

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1. Introduction

The raw PPO polymer has some excellent properties but the price is restrictive and very little of this material is manufactured. The ability of PPO to be blended with polystyrene lead to the introduction in 1966 of the 'Noryl'™ family of polymers by General Electric Plastics. This family is sometimes called PPO but in fact is more correctly a blend of PPO and polystyrene. These types of material have some excellent properties and the price point (more than ABS but less than PC) means that applications are plentiful - especially when some of the excellent properties can be used to their full extent. This polymer data file refers to PPO/PS blends rather than to the raw PPO polymers.

2. Typical applications

Mechanical: Machine housings, pump housings and impellers.

Consumer goods: Power tool housings, portable mixers, hairdryers.

Automotive: Instrument panels and seat backs, spoilers, wheel trims, external mirror housings.

Electrical: Electrical terminal housings, cable connectors, bulb sockets, coil formers.

Miscellaneous: Plastic parts in central heating systems.

3. Physical and mechanical properties

PPO blends have a high heat distortion resistance, low water absorption and high strength. PPO blends have a wide application temperature range (-40 to 130˚C).

The PPO blends can be substantially modified by including rubber impact modifiers and other alloying agents to modify the properties of the original alloy. One typical alloy is 'PPO + PA' which is used as a replacement for PA in automotive applications that may need to with stand paint stoving lines.

PPO can be produced in structural foam variants and these have significantly different properties to those listed below.

Mechanical properties

Property	Approximate Value	
	PPO	PPO (30%GF)
Tensile Strength	55 - 80 MN/m^2	>105 MN/m^2
Tensile Modulus	2 - 3 GN/m^2	>4 GN/m^2
Elongation at Break	10 - 50%	<10%
Flexural Strength	50 - 100 MN/m^2	100 - 150 MN/m^2
Notched Impact Strength	10 - 20 kJ/m^2	3 - 10 kJ/m^2
Specific Heat	1.25 - 1.70 kJ/kg/˚C	0.8 - 1.25 kJ/kg/˚C
Glass Transition Temperature	50˚C	50˚C
Heat Deflection Temperature	100 - 150˚C	100 - 150˚C
Coefficient of Thermal Expansion	5 - 10 x 10^{-5} /˚C	<5 x 10^{-5} /˚C
Long Term Service Temperature	100 - 150˚C	100 - 150˚C
Specific Gravity	1.0 - 1.2	1.2 - 1.4

Mould Shrinkage	0.005 - 0.01 m/m	0.001 - 0.005 m/m
Water Absorption	0.1 - 0.5 % (50% rh)	<0.1 % (50% rh)
Transparency	Opaque	Opaque

4. Thermal, electrical and optical properties

Thermal properties

PPO has a higher heat deformation resistance than many general-purpose thermoplastics at a lower price than the more expensive 'engineering thermoplastics'. One of the main reasons for using the PPO blends is the outstanding dimensional stability at elevated temperatures and the broad temperature use range.

Fire behaviour

Conventional grades are non self-extinguishing but self-extinguishing grades (generally made by including phosphorous based additives) are available with a slightly lower heat distortion temperature and impact strength. As a general rule the materials are difficult to ignite and burn with a sooty luminous flame and a pungent odour but do not drip. The flammability ranges from UL 94 HB to V-0 depending on the grade tested.

Electrical properties

Moisture absorption is low over a wide range of humidity levels and therefore dielectric properties are excellent over a wide range of moisture and temperature conditions.

Optical properties

Natural PPO blends are opaque but can easily be coloured a wide range of colours.

5. Chemical resistance properties

PPO blends are resistant to acids, alkalis, most salt solutions and alcohols

PPO blends are not resistant to benzene, chlorohydocarbons, ketones and many halogenated or aromatic hydrocarbons.

Dimensional changes are negligible even in boiling water.

No detailed chemical resistance chart is available.

Weathering resistance:

PPO blends have good weathering resistance when adequately stabilised but uncoloured grades will yellow in UV. Black grades have the best UV resistance.

Stress cracking resistance:

Stress cracking resistance is high for most common solvents at low temperatures.

6. Advantages and limitations

Advantages	Limitations
1. Good dimensional stability.	1. Must be coloured for acceptable visual finish
2. Low moulding shrinkage.	2. Higher price than commodity plastics.

3. Low water absorption.	3. Higher processing temperatures required for some grades.
4. Good resistance to hydrolysis.	4. Limited supplier base.
5. Excellent dielectric properties over wide temperature range.	
6. Heat distortion over 100˚C and in some grades as high as 160˚C	

7. Processing

PPO blends generally have excellent processing stability and can be processed on most conventional equipment but the processing temperatures and pressures are sometimes higher than for other polymers.

PPO has good dimensional stability and a low mould shrinkage and this allows the production of mouldings and extrusions with close dimensional tolerances. The fibre reinforced grades have an even lower mould shrinkage than the unreinforced grades.

Pre-drying is normally only necessary if the granules have been stored under damp conditions or if a high gloss finish is needed. In this case 2 hours at 100˚C is generally sufficient.

Injection moulding

Typical melt temperatures of 250 to 300˚C are needed with a die head temperature of around 250˚C. The injection pressure should be 1000 to 1200 bar and the follow-up pressure should be 50 - 70% of the injection pressure. The back pressure should be set at 30 - 50 bar. The mould temperature should be in the region of 80 to 105˚C.

Injection speed is generally high but moulds with a long flow path should have adequate mould venting.

Mould shrinkage is low (0.005 - 0.01 m/m).

Extrusion

PPO is relatively easy to extrude and can be processed on single or twin-screw extruders and on vented or unvented extruders.

Regrind (provided it is dry) can be used without adverse effects.

Process selector

Processing Method	Applicable
Injection Moulding	Yes
Extrusion	Yes
Extrusion Blow Moulding	Yes
Injection Blow Moulding	No
Rotational Moulding	No
Thermoforming	Yes
Casting	Yes

Bending and joining	Yes

8. Finishing

Machining

PPO blends can be machined without difficulty using standard machine conditions for polymers. The products are difficult to cut and machining needs to be slow (feeds and speeds).

Surface treatment

PPO blends can be painted with good coatability. A primer and a polyurethane type of paint is recommended

Hot stamping, hot foiling and printing can also be used.

Welding

PPO can be solvent welded using commercially available solvents and solvent solutions containing 1 to 7% PPO resin.

Note: Use isopropyl alcohol to clean areas and equipment after use.

Bonding

PPO blends can be bonded using a wide range of commercially available adhesives including epoxy adhesives.

9. Health and safety

PPO does not constitute a health hazard but is not widely used in food contact applications.

10. Other information

Identification

Burns with a sooty luminous flame and a pungent phenol odour but does not drip.