Plastics Data File – PES

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1. Introduction

PES is a high temperature amorphous engineering thermoplastic with excellent thermal stability, an ability to withstand loads at temperatures of up to 180°C for long periods and an ability to retain many mechanical and electrical properties at temperatures up to 210°C. The material is tough and rigid at all temperatures to 210°C. Creep performance is good especially when glass reinforced.

Products are dimensionally stable at temperatures up to 210°C.

2. Typical applications

Automotive: Cooling system fans and other high temperature applications.

Electrical engineering: Relay and switch bodies, injection moulded printed circuit boards, lamp reflectors.

Domestic: Hot water meters and valves, electrically heated styling brushes.

Medicine: Laboratory centrifuges, lamps and reflectors, dental equipment.

Others: Aviation electrical components, weapons systems components, plastic bearing cages, radomes, oven components.

3. Physical and mechanical properties

General physical properties

PES is a high temperature engineering thermoplastic that retains many properties up to high temperatures (in the region of 210˚C) but also retains many properties down to -70˚C.

Creep performance is good to high temperatures (especially when glass reinforced).

Mechanical properties

Property	Approximate Value	
	PES	PES (30% GF)
Tensile strength	80 - 105 MN/m^2	>105 MN/m^2
Tensile Modulus	2-3 GN/m^2	>4 GN/m^2
Elongation at Break	50 - 100 %	<10 %
Flexural Strength	100 - 150 MN/m^2	150 - 200 MN/m^2
Notched Impact Strength	3 - 10 kJ/m^2	3 - 10 kJ/m^2
Specific Heat	N/A	N/A
Glass Transition Temperature	230˚C	230˚C
Heat Deflection Temperature	200 - 250˚C	200 - 250˚C
Coefficient of Thermal Expansion	5 - 10 x 10^{-5} /˚C	<5 x 10^{-5} /˚C

Long Term Service Temperature	150 - 200˚C	150 - 200˚C
Specific Gravity	1.2 to 1.4	1.4 to 1.6
Mould Shrinkage	0.01 - 0.025 m/m	0.005 - 0.01 m/m
Water Absorption	0.1 - 0.5 % (50% rh)	0.1 - 0.5 % (50% rh)
Transparency	Transparent	Opaque

4. Thermal, electrical and optical properties

Thermal properties

PES has a UL temperature index of 180˚C and retains dimensional stability to high temperatures.

Fire behaviour

PES has low flammability and has a UL 94 V-0 rating down to thicknesses of 0.43mm. Smoke and toxic gas emissions are low during burning.

Electrical properties

PES has excellent electrical insulation properties but tracking resistance is not good.

PES is radar transparent.

Optical properties

N/A

Natural colour

Natural colour is translucent amber/brown. Can be dyed for transparent colours or pigmented for opaque colours.

5. Chemical resistance properties

General

PES is resistant to oils and petrol at high temperatures and is resistant to a wide pH range of acids and alkalis. It is also resistant to aliphatic hydrocarbons, alcohols, benzene, fats and cleaning and degreasing agents.

PES is not resistant to concentrated mineral acids, ketones, chlorinated and aromatic hydrocarbons and many organic materials (chloroform, acetone, cyclohexanone, ethyl acetate etc.).

PES has excellent hydrolysis resistance and can withstand long term loads in contact with pressurised water at 150˚C. Glass reinforced grades are particularly good in this type of application.

A detailed chemical resistance chart for PES is given in Section 11.

PES can be sterilised using most common hospital sterilisation methods.

Weathering and resistance to stress cracking.

PES can be used for long term outdoor exposure only when protected by carbon black pigments or UV stabilisers.

6. Advantages and limitations

Advantages	Limitations
1. Excellent high temperature properties.	1. High cost.
2. Excellent creep resistance.	2. Narrow processing window and high temperatures needed.
3. Good chemical resistance to common chemicals at elevated temperatures.	3. High levels of moulded in stress possible.

7. Processing

PES can be processed using conventional injection moulding and extrusion equipment and close tolerances can be achieved. Processing temperatures should not be increased too much otherwise overheating and darkening can occur.

PES should be dried at 150˚C for 3 hours before processing to give less than 0.04% water content.

Injection moulding

PES has a high melt viscosity and suffers from burning if the temperature or shear rate is too high. This gives a narrow processing window and care needs to be taken in processing to avoid overshearing the material.

Melt temperature of 360˚C using a screw with an L/D of 20:1. Use a high injection speed with a low screw speed (to minimise shear rate and shear degradation) and an injection pressure of 2000 bar /1200 bar. Mould temperature should be around 150˚C.

Sprue removal is by cropping while the material is still hot.

The high processing temperatures can give rise to concerns with moulded-in stress and it is recommended that mouldings are annealed after moulding at 160 - 200˚C.

Extrusion

Melt temperatures should be in the region of 300 - 360˚C.

Up to 30% PES can be reground and recycled after drying.

Process selector

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

8. Finishing

Machining

PES can be machined or cropped.

Surface treatment

PES can be vacuum metallised, electroplated, painted or etched.

Welding

PES can be welded by friction, heat and ultrasound welding.

Bonding

Solvent weld with methylene chloride.

9. Health and safety

PES has no significant Health and Safety implications and has been approved for use in contact with potable water and for food contact.

10. Other information

Identification

Sinks in water.

Does not burn easily but gives off white flame and odour of sulphur with little smoke emission.

Tapping gives metallic ring.

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11. Detailed chemical resistance

Important Note:

Whilst we try to ensure that this table is as accurate as possible, we cannot guarantee that the data contained in the tables is accurate for all blends and grades. In all cases the supplier of the material should be contacted to determine the exact chemical resistance of the material.

R = Resistant, LR = Limited Resistance, NR = Not Recommended, ND = No Data

Chemical	Resistance		
	20˚C	60˚C	100˚C
Acetaldehyde	ND	ND	ND
Acetic acid (10%)	R	R	R
Acetic acid (glac./anh.)	R	R	R
Acetic anhydride	R	R	R
Aceto-acetic ester	ND	ND	ND
Acetone	NR	NR	NR
Other ketones	NR	NR	NR
Acetonitrile	R	R	NR
Acetylene	R	ND	ND
Acetyl salicylic acid	ND	ND	ND
Acid fumes	ND	ND	ND
Alcohols	R	R	R
Aliphatic esters	R	ND	ND
Alkyl chlorides	ND	ND	ND
Alum	R	ND	ND
Aluminium chloride	R	ND	ND
Aluminium sulphate	NR	NR	NR
Ammonia, anhydrous	ND	ND	ND
Ammonia, aqueous	R	ND	ND
Ammonium chloride	R	ND	ND
Amyl acetate	R	ND	ND

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Chemical	Resistance		
	20˚C	60˚C	100˚C
Aniline	ND	ND	ND
Antimony trichloride	ND	ND	ND
Aqua regia	ND	ND	ND
Aromatic solvents	R	ND	ND
Ascorbic acid	ND	ND	ND
Beer	R	R	R
Benzaldehyde	ND	ND	ND
Benzene	NR	NR	NR
Benzoic acid	R	ND	ND
Benzoyl peroxide	ND	ND	ND
Boric acid	R	ND	ND
Brines, saturated	R	R	ND
Bromide (K) solution	NR	NR	NR
Bromine	NR	NR	NR
Bromine liquid, tech.	NR	NR	NR
Bromine water, saturated aqueous	NR	NR	NR
Butyl acetate	ND	ND	ND
Calcium chloride	R	R	R
Carbon disulphide	R	ND	ND
Carbonic acid	R	ND	ND
Carbon tetrachloride	R	ND	ND
Caustic soda & potash	R	R	ND
Cellulose paint	ND	ND	ND
Chlorates of Na, K, Ba	R	ND	ND
Chlorine, dry	ND	ND	ND
Chlorine, wet	ND	ND	ND

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Chemical	Resistance		
	20˚C	60˚C	100˚C
Chlorides of Na, K, Ba	R	ND	ND
Chloroacetic acid	ND	ND	ND
Chlorobenzene	NR	NR	NR
Chloroform	NR	NR	NR
Chlorosulphonic acid	NR	NR	NR
Chromic acid (80%)	R	R	R
Citric acid	R	ND	ND
Copper salts (most)	R	R	R
Cresylic acids (50%)	ND	ND	ND
Cyclohexane	R	ND	ND
Detergents, synthetic	R	ND	ND
Emulsifiers, concentrated	R	ND	ND
Esters	ND	ND	ND
Ether	R	ND	ND
Fatty acids (>C6)	R	ND	ND
Ferric chloride	R	ND	ND
Ferrous sulphate	R	ND	ND
Fluorinated refrigerants	NR	NR	NR
Fluorine, dry	NR	NR	NR
Fluorine, wet	NR	NR	NR
Fluorosilic acid	NR	NR	NR
Formaldehyde (40%)	R	ND	ND
Formic acid	R	ND	ND
Fruit juices	R	ND	ND
Gelatine	R	ND	ND
Glycerine	R	ND	ND

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Chemical	Resistance		
	20˚C	60˚C	100˚C
Glycols	R	ND	ND
Glycol, ethylene	NR	NR	NR
Glycolic acid	ND	ND	ND
Hexamethylene diamine	ND	ND	ND
Hexamine	ND	ND	ND
Hydrazine	ND	ND	ND
Hydrobromic acid (50%)	ND	ND	ND
Hydrochloric acid (10%)	R	R	ND
Hydrochloric acid (conc.)	R	R	ND
Hydrocyanic acid	ND	ND	ND
Hydrofluoric acid (40%)	NR	NR	NR
Hydrofluoric acid (75%)	NR	NR	NR
Hydrogen peroxide (30%)	R	ND	ND
Hydrogen peroxide (30 - 90%)	R	ND	ND
Hydrogen sulphide	R	ND	ND
Hypochlorites	R	ND	NR
Hypochlorites (Na 12-14%)	NR	NR	NR
Iso-butyl-acetate	ND	ND	ND
Lactic acid (90%)	ND	ND	ND
Lead acetate	R	ND	ND
Lead perchlorate	ND	ND	ND
Lime (CaO)	R	ND	ND
Maleic acid	R	ND	ND
Manganate, potassium (K)	NR	NR	NR
Meat juices	R	ND	ND
Mercuric chloride	R	ND	ND

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Chemical	Resistance		
	20˚C	60˚C	100˚C
Mercury	R	ND	ND
Methanol	NR	NR	NR
Methylene chloride	NR	NR	NR
Milk products	R	ND	ND
Moist air	R	R	R
Molasses	R	ND	ND
Monoethanolamine	R	R	R
Naptha	R	ND	ND
Napthalene	ND	ND	ND
Nickel salts	R	ND	ND
Nitrates of Na, K and NH3	R	ND	ND
Nitric acid (<25%)	R	ND	ND
Nitric acid (50%)	ND	ND	ND
Nitric acid (90%)	NR	NR	NR
Nitric acid (fuming)	NR	NR	NR
Nitrite (Na)	NR	NR	NR
Nitrobenzene	NR	NR	NR
Oils, diesel	NR	NR	NR
Oils, essential	R	ND	ND
Oils, lubricating + aromatic additives	NR	NR	NR
Oils, mineral	R	R	R
Oils, vegetable and animal	R	R	R
Oxalic acid	ND	ND	ND
Ozone	R	ND	ND
Paraffin wax	R	ND	ND
Perchloric acid	NR	NR	NR

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Chemical	Resistance		
	20˚C	60˚C	100˚C
Petroleum spirits	NR	NR	NR
Phenol	NR	NR	NR
Phosphoric acid (20%)	R	R	R
Phosphoric acid (50%)	R	R	R
Phosphoric acid (95%)	R	R	R
Phosphorous chlorides	ND	ND	ND
Phosphorous pentoxide	ND	ND	ND
Phthalic acid	ND	ND	ND
Picric acid	ND	ND	ND
Pyridine	NR	NR	NR
Salicyl aldehyde	ND	ND	ND
Sea water	R	R	R
Silicic acid	ND	ND	ND
Silicone fluids	R	ND	ND
Silver nitrate	R	ND	ND
Sodium carbonate	R	ND	ND
Sodium peroxide	ND	ND	ND
Sodium silicate	NR	NR	NR
Sodium sulphide	R	ND	ND
Stannic chloride	R	ND	ND
Starch	R	ND	ND
Sugar, syrups & jams	R	R	R
Sulphamic acid	ND	ND	ND
Sulphates (Na, K, Mg, Ca)	R	R	R
Sulphites	R	R	R
Sulphonic acids	ND	ND	ND

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Chemical	Resistance		
	20˚C	60˚C	100˚C
Sulphur	ND	ND	ND
Sulphur dioxide, dry	R	ND	ND
Sulphur dioxide, wet	NR	NR	NR
Sulphur dioxide (96%)	R	ND	ND
Sulphur trioxide	R	ND	ND
Sulphuric acid (<50%)	R	ND	ND
Sulphuric acid (70%)	R	ND	ND
Sulphuric acid (95%)	NR	NR	NR
Sulphuric acid, fuming	NR	NR	NR
Sulphur chlorides	ND	ND	ND
Tallow	R	ND	ND
Tannic acid (10%)	ND	ND	ND
Tartaric acid	R	ND	ND
Trichlorethylene	NR	NR	NR
Urea (30%)	R	NR	NR
Vinegar	R	R	R
Water, distilled.	R	R	R
Water, soft	R	R	R
Water, hard	R	R	R
Wetting agents (<5%)	NR	NR	NR
Yeast	R	ND	ND
Zinc chloride	R	ND	ND