Plastics Data File – POM (Acetal)

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1. Introduction

POM is a highly crystalline linear thermoplastic which has predictable mechanical, chemical and other properties over a wide time and temperature range. As for PP the material is available in homopolymer and copolymer grades.

POM is rigid, translucent and tough with good spring like qualities, it has good wear and electrical properties and it is generally resistant to creep and most organic solvents. The high heat distortion temperature makes it suitable for many applications at elevated temperatures and it can also be used at temperatures down to -40°C.

POM does show some notch sensitivity.

The higher cost of POM (in comparison to the commodity plastics) reduces the application range but it is also one of the cheaper 'engineering' thermoplastics.

2. Typical applications

Mechanical engineering: Clock and watch parts, rollers, bearings, gearwheels, housing parts.

Household goods: Control dials, pump parts, valves, gears.

Office equipment: General business machine parts, spring and screen parts, coils, rewind rollers for radio and video cassettes, precision parts for measurement and control technology.

Transportation: Snap fittings and fixing parts for interior linings, functional parts in the heating, ventilation and coolant sector, door handles, styling strips, seat belt components.

Plumbing and installation sector: Small pressure vessels, sound-damping mountings for WCs and bathrooms, pump and filter housings, fittings, hinges.

Consumer sport and leisure sector: Aerosol valves and heads, disposable cigarette lighters, ski bindings, toy parts.

3. Physical and mechanical properties

General

POM is not hygroscopic and water absorption is very low, dimensional stability is good with changes in humidity.

POM has a relatively high density of 1.41 and POM parts are heavier than equivalent parts in other plastics.

POM has a relatively high shrinkage of 2%, due to the crystallinity effects and this must be taken into account in tool design.

POM has an ideal combination of strength, stiffness and toughness. The stiffness and strength, particularly in the temperature range of 50 to 120°C, are greater than those of most other thermoplastics. At room temperature, POM has a distinct yield point at approximately 8 to 10% elongation. Below the yield point it has good elastic recovery, even when stressed repeatedly and this gives good spring capacity and suitability for snap fastenings.

POM also has high creep strength and a low creep tendency. This combination of properties in conjunction with good wear resistance and a low dynamic friction coefficient make it suitable for demanding industrial applications.

The strength, E modulus and deflection temperature under load can be increased by glass fibre reinforcement.

POM has a low co-efficient of friction (0.1 - 0.3) against itself or other materials, but this can be improved by blending with molybdenum disulphide or PTFE.

Mechanical properties

Property	Approximate Value	
	POM	POM - Glass filled
Tensile strength	55 - 80 MN/m^2	80 - 105 MN/m^2
Tensile Modulus	3-4 GN/m^2	>4 GN/m^2
Elongation at Break	10 - 50 %	<10 %
Flexural Strength	100 - 150 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	1.25 - 1.70 kJ/kg/°C
Glass Transition Temperature	-76°C	
Heat Deflection Temperature	100 - 150°C	150 - 200°C
Coefficient of Thermal Expansion	5 - 10 x 10^{-5} /°C	5 - 10 x 10^{-5} /°C
Long Term Service Temperature	90°C	100 - 150°C
Specific Gravity	1.41	>1.6
Mould Shrinkage	0.01 - 0.025 m/m	0.005 - 0.025 m/m
Water Absorption	0.1 - 0.5 % (50% rh)	0.1 - 0.5 % (50% rh)
Transparency	Opaque	Opaque

4. Thermal, electrical and optical properties

Thermal properties

POM has a narrow melting point range (164 to 168°C for the copolymer). Parts can withstand thermal stresses up to temperatures approaching this melting range for very short periods without distortion.

The co polymer glass transition temperature is -60°C. At temperatures just over 100°C, molecular movement takes place in the crystalline region and deflections under load begin to become significant. POM copolymer is more thermally stable than the POM homopolymer.

Permissible service temperatures under hot conditions are 140°C (for under short terms) and 80 to 100°C under constant stress. At 120°C the material will start to become brittle after three months and then rapidly decrease in strength.

Fire behaviour

POM is rated as UL 94-HB and the material is a slow clean burning material with little or no smoke generation. The homopolymer has a high self-ignition temperature of 376oC and is classified as slow-burning.

Electrical properties

POM has a high electrical insulating capacity, high electrical strength and good dielectric behaviour. The low moisture absorption of the material makes it highly suitable for electrical applications.

Optical properties

POM is opaque and uncoloured moulded parts are translucent to white. All muted colours can be produced and a good surface gloss can be achieved from a polished tool and correct moulding conditions.

5. Chemical resistance properties

POM has excellent chemical resistance to organic compounds with the exception of halogenated hydrocarbons where the resistance is lower. Chemicals to which POM is resistant include alcohols, aldehydes, esters, ethers, glycols, hydrocarbons (petrol, engine oil), agricultural chemicals, weak acids and alkalis.

A detailed chemical resistance chart is given in Section 11.

Weathering

POM is susceptible to UV radiation and if exposed to sunlight for long periods, the parts lose their surface gloss and become brittle. UV stabilisers can be added to double the service life, but marked improvements can be achieved by adding 2 to 3% of a special type of carbon black.

Stress cracking

POM has good stress crack resistance in the air, but stress cracking is a concern in some gases and liquids.

6. Advantages and limitations

Advantages	Limitations
1. Excellent combination of toughness, rigidity, fatigue strength, and creep resistance (suitable for clips and springs).	1. Attacked by strong mineral acids.
2. Good moisture and chemical resistance; resistant to nearly all organic solvents and alkali solvents.	2. Homopolymers are not stable in alkalis.
3. Good dimensional stability over a wide temperature range (-40°C to 165°C).	3. Adversely affected by prolonged exposure to UV in standard in pigmented form.
4. Maximum service temperature 90 to 120°C, depending on grade, stress, and time.	4. Molecular structure is such that non-flammable forms are not practicable.
5. High resistance to thermal and oxidative degradation.	5. Above about 115oC significant changes in physical properties occur, particularly weight loss and change in metal-flow index.
6. Very good resistance to stress relaxation.	6. Cannot be used for applications involving high electric stress or power frequencies at temperatures above 70°C.
7. Good friction and wear properties.	7. Materials in moulded form normally contain traces of free formaldehyde (4 ppm.) which could be absorbed by foodstuffs.

8. Low gas and vapour permeability.	8. Strains in well-fabricated components for long-term applications should not exceed 2 to 5 per cent.
9. Processable by conventional techniques or injection moulding with excellent dimensional accuracy and post-moulding stability.	9. Fillers can reduce strength and elongation.
10. Range of grades available with or without fillers, additives etc. for specific applications.	10. Joining to self or other materials is difficult.

7. Processing

Injection moulding

Pre-drying is not necessary but can be carried out at 110°C for 2 hours if the material has become moist or if the uniformity of the material needs to be improved.

Injection pressures of 1200 to 1500 bar are used depending on the viscosity of the melt, the flow to wall thickness ratio and the type of sprue. Processing temperature is 180 to 220°C and up to 230°C in the event of deep flow and thin walls. The best processing temperature is around 205°C. Thermal damage may occur above 230°C unless the residence time in the cylinder is kept short.

At a mould temperature of 120°C the mouldings are tougher and have greater rigidity and the general range is 50 to 120°C. The material is partially crystalline thermoplastics and the mechanical properties are determined by the degree of crystallisation which increases with the mould temperature. Mould tempering is important in the production of high surface quality parts with low distortion and care needs to be taken in this area. Mouldings produced at 90°C have less post-shrinkage than mouldings produced at lower temperatures. Mould shrinkage is about 2% but is greatly dependent on the processing conditions. The glass fibre reinforced materials types have lower shrinkage but distortion can occur if the shrinkage is not uniform. Moulded parts with a high accuracy in gauge or parts used at high temperatures can be tempered for 24 hours at 110 to 140°C in order to allow for post-shrinkage.

As with all crystalline polymers the follow-up pressure can be influential on the shrinkage of the part and a longer hold time is preferred to reduce shrinkage.

High thermal stress during processing will result in the formation of formaldehyde.

Extrusion

Extrusion mainly to produce semi-finished articles (round and flat rods, hollow rods, slabs) and can be carried out easily on single and multi-screw extruders. The extrusion temperatures are between 180 and 220°C.

High molecular weight types are the most suitable; highly viscous types with a good melt strength are best for extrusion blow moulding.

Short or long compression screws should have an L/D ratio of 15 to 25.

Process selector

Processing Method	Applicable
Injection Moulding	Yes
Extrusion	Yes
Extrusion Blow Moulding	Yes

Injection Blow Moulding	Yes
Rotational Moulding	Yes
Thermoforming	Yes
Compression Moulding	Yes
Casting	No
Bending and joining	Yes (but sometimes difficult)

8. Finishing

Machining

POM is easily machined. Use a high cutting speed with a slow feed. Cutting coolants are not required. It is important to use sharp tools so as to avoid excessive heat development.

Surface treatment

The smooth hard surface and the good chemical resistance of POM requires pre-treatment to improve the adhesion of coatings. This pre-treatment can be by mechanical roughening, chemical etching or by applying and baking lacquers. There are special printing inks and embossing foils for printing and hot stamping; these give sufficient bond and wipe strength without any pre-treatment of the surfaces.

Welding

POM can be welded by the hot gas, heated tool, ultrasonic, friction (spin) and vibration welding methods. High frequency welding is not suitable.

Bonding

Bonding is difficult because of the good chemical resistance and bond strengths will always be low. Gas-tight, air-tight and moisture-tight joints can be obtained with impact, reactive and polyisocyanate adhesives, but they have only low mechanical strength.

9. Health and safety

POM is suitable for food contact applications and for use with potable water.

10. Other Information

Identification

Sample will be difficult to ignite but will burn with a yellow flame and smell strongly of formaldehyde.

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	R	ND	ND
Acetic acid (10%)	R	ND	ND
Acetic acid (glac./anh.)	LR	ND	ND
Acetic anhydride	LR	ND	ND
Aceto-acetic ester	ND	ND	ND
Acetone	R	ND	ND
Other ketones	LR	ND	ND
Acetonitrile	ND	ND	ND
Acetylene	R	ND	ND
Acetyl salicylic acid	ND	ND	ND
Acid fumes	ND	ND	ND
Alcohols	R	ND	ND
Aliphatic esters	R	ND	ND
Alkyl chlorides	R	ND	ND
Alum	LR	ND	ND
Aluminium chloride	LR	ND	ND
Aluminium sulphate	LR	ND	ND
Ammonia, anhydrous	R	ND	ND
Ammonia, aqueous	R	ND	ND
Ammonium chloride	R	ND	ND

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

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

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

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

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

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