Plastics Data File – PA (Nylon)

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Plastics Data File – PA (Nylon)

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1. Introduction

Nylon is used as a generic name for the polyamide group of polymers but was originally the name given by Du Pont (in the USA) to the fibre discovered by Wallace Hume Carothers in 1934.

The polyamide products can be formed by two general methods and this gives two distinct classes of polyamides.

Condensation polymerisation:

The polymers formed by condensation reactions of a dibasic acid and a diamine are the PA 6/6 types of PA. Other variants (which are created by using different dibasic acids) are PA 6/10 and PA 6/12.

Addition polymerisation:

The polymers formed by addition reactions of ring compounds. Typical variants are PA 6, PA 11, PA 12 and PA 46.

It is theoretically possible to produce many different types of PA polymers and all tend to be labelled carelessly under the heading of 'Nylon'. Given the multitude of variants and range of physical and chemical properties this is unwise. In this data file we will try to be specific with regard to the variant being referred to but sometimes the source information is not always clear. The largest volume sales are of the PA 6 and PA 6/6 variants. The other materials tend to be specialist polymers at specialist prices. In most cases the information refers to these materials.

As a general family the PA group is rigid, translucent with good fatigue, creep and wear resistance. Chemical resistance varies with the variant but is generally good.

2. Typical applications

Mechanical: Gear wheels, bearings, rollers, cam-wheels, screws, control rollers.

Consumer goods: Bicycle wheels, hair brushes and combs, per tool housings, Strimmer cable.

Automotive: Fans, fuel system pipe work, oil filters, floats, bearings, tachometer drive pinions, speedometer and windshield wiper gears, jets for windscreen washer systems, radiator header tanks.

Electrical: Coil formers, card guides, terminal blocks, distribution boxes, vacuum cleaners, hand lamps, abrasion-resistant cable ducts.

Miscellaneous: Zips, fibres, nuts and bolts, pressure tubing, pump housings, laboratory equipment, furniture fittings, medical instruments.

3. Physical and mechanical properties

All the properties of PA depend on the moisture content of the plastic and the crystallinity of PA variant being used. PA can be tough when the moisture content is right (2–3% in air at 20°C) but dry products tend to become brittle. The equilibrium moisture content depends on the time, temperature and wall thickness of the part. Dimensional and physical property changes take place during moisture absorption and injection moulded parts are often annealed or conditioned after processing to optimise the physical properties quickly.

PA has good temperature stability, abrasion resistance and fatigue resistance.

The crystalline nature of PA also affects the properties significantly and highly crystalline types can be stiff and hard. The use of glass fibre and other reinforcements can improve the mechanical properties (modulus and strength).

The density, equilibrium moisture content and shrinkage vary with the PA variant used.

Mechanical properties

Property	Approximate Value			
	PA 6	PA6/6	PA 11	PA 12
Tensile strength	55 - 80 MN/m	55 - 80 MN/m^2	30 - 55 MN/m^2	30 - 55 MN/m^2
Tensile Modulus	1 - 2 GN/m^2	2 - 3 GN/m^2	1 - 2 GN/m^2	<1 GN/m^2
Elongation at Break	100 - 500 %	100 - 500 %	100 - 500 %	100 - 500 %
Flexural Strength	50 - 100 MN/m^2	50 - 100 MN/m^2	50 - 100 MN/m^2	50 - 100 MN/m^2
Notched Impact Strength	3 - 10 kJ/m^2	3 - 10 kJ/m^2	3 - 10 kJ/m^2	10 - 20 kJ/m^2
Specific Heat	1.25 - 1.70 kJ/kg/°C	1.25 - 1.70 kJ/kg/°C	2.15 - 2.60 kJ/kg/°C	1.70 - 2.15 kJ/kg/°C
Glass Transition Temperature	50°C	66°C	approx. 50°C	Approx. 50°C
Heat Deflection Temperature	<100°C	100 - 150°C	<100°C	<100°C
Coefficient of Thermal Expansion	10 - 15 x 10^{-5} / °C	10 - 15 x 10^{-5} / °C	10 - 15 x 10^{-5} / °C	10 - 15 x 10^{-5} / °C
Long Term Service Temperature	<100°C	<100°C	<100°C	<100°C
Specific Gravity	1.0 - 1.2	1.0 - 1.2	1.0 - 1.2	1.0 - 1.2
Mould Shrinkage	0.01 - 0.025 m/m	0.01 - 0.025 m/m	0.01 - 0.025 m/m	0.005 - 0.02 m/m
Water Absorption	>2 % (50% rh)	>2 % (50% rh)	>2 % (50% rh)	1.0 - 2.0 % (50% rh)
Transparency	Opaque	Opaque	Opaque	Opaque

4. Thermal, electrical and optical properties

Thermal properties

PA has good high temperature performance and depending on the variant can be used between 80 and 120°C, some stabilised variants can be used for short periods at up to 200°C.

PA can be used down to about -40°C, at this temperature the copolymers will still fail in a ductile manner but the homopolymers will generally fail in a brittle manner.

PA has a low linear coefficient of thermal expansion and is dimensionally stable nearly up to the melt region when unloaded. Reinforcement with glass fibre gives excellent dimensional stability with changes in temperature.

Fire behaviour

Most PA variants are flammable and start to decompose at above 300°C. Above 450 to 500°C the burning becomes self-sustaining and the PA will continue to burn when the source of ignition is removed. When burning, the material bubbles and drips and threads can be pulled from the molten material. The flame is blue and has the odour of burning horn. Some variants are self-extinguishing.

Electrical properties

The electrical properties of all PA variants are strongly dependent on moisture content. The polar nature of PA means that the electrical properties are also dependent on the frequency. Specific details relevant to the variants and grade to be used should be obtained before using PA in electrical applications.

Optical properties

Natural PA is milky-opaque but can be easily coloured in a wide variety of colours. PA has a refractive index which varies with the variant and for most types it is in the region of 1.52 to 1.53.

5. Chemical resistance properties

PA has good chemical resistance to aliphatic and aromatic hydrocarbons, benzene, oils, fats, certain alcohols, esters, ketones, ether, organic and inorganic bases up to medium concentration and to chlorinated hydrocarbons. Some chemicals e.g., chloroform and methylene chloride, produce significant swelling and others are e.g., alcohols, cause similar swelling to water. PA is not resistant to mineral acids, strong caustic solutions, solutions of oxidising agents, formic acid, phenols, cresols and glycols.

A detailed chemical resistance chart for PA 6 is given in Section 11.

A detailed chemical resistance chart for PA 6/6 is given in Section 12.

A detailed chemical resistance chart for PA 11 is given in Section 13.

A detailed chemical resistance chart for PA 12 is given in Section 14.

Weathering resistance

PA has good resistance to ageing and weathering and this can be improved with suitable additives (carbon black improves UV and general weathering performance). Reinforced PA suffers from more surface attack at the glass fibre interfaces and significant visible damage can occur in a short time, this does not generally significantly affect the mechanical properties.

Stress cracking resistance

Low tendency to stress cracking.

6. Advantages and limitations

Advantages	Limitations
1. Good combination of mechanical properties (fatigue and creep strength, stiffness, toughness and resilience), which are only slightly inferior to those of polyacetals.	1. All PA variants absorb or give up moisture to achieve equilibrium with ambient conditions; moisture acts as a plasticiser, decreasing tensile and creep strengths and increasing impact strength and the dimensions of the component.

2. Good abrasion resistance and self-lubricating properties give widespread use in gears and bearings.	2. Electrical properties are greatly influenced by moisture content.
3. Suitable for prolonged service temperatures of 80-100°Cand up to 140°C with heat-stabilized grades.	3. Thermal expansion varies with temperature and moisture content.
4. Can be used in contact with most foodstuffs at room temperature; sterilized by steam or infra-red radiation.	4. All PA variants are attacked by strong mineral acids and acetic acid, and are dissolved by phenols.
5. Resistant to fuels, oils, fats, and most technical solvents, such as aliphatic and aromatic hydrocarbons, chlorinated hydrocarbons, esters, ketones, and alcohols.	5. Unstabilised PA is are attacked by UV, which causes embrittlement in a comparatively short time.
6. Good alkali resistance.	6. PA has sharply defined melting points, and high shrinkage values occur on moulding of thick sections.
7. Wide range of fillers and additives can improve specific properties and reduce limitations of unmodified materials, e.g., effects of moisture on dimensions and properties can be greatly reduced by use of glass-fibre filler.	7. The crystalline nature of PA gives longer cycle times in moulding.
8. Almost all plastics processing methods can be used.	

7. Processing

PA is hygroscopic and materials should be stored in sealed and moisture resistant containers. Hoppers should also be sealed to prevent moisture uptake. Moisture contents of greater than 0.25% can give problems during processing. Pre-drying at 80˚C for 16 hours is recommended if the material has been left open to the air.

PA has a broad processing range and the easy processability means that almost all of the conventional polymer processing methods can be used with PA.

Injection moulding

Mould temperature is usually between 60 and 90˚C but this can be increased to 100˚C or even 120˚C where high dimensional accuracy is required. This gives a higher level of crystallinity and better mechanical properties.

Processing parameters differ with the variants and the PA 6 types generally require cooler processing temperatures (220 - 230˚C) than the PA 6/6 types (270 - 280˚C).

Back pressures should be set low (20 - 50 bar) and very precisely with vented cylinders to prevent material oozing from the vent port.

Injection speed should be relatively high and a high screw speed can be used.

After moulding the crystallinity of PA may require post treatment. For mouldings to be used over 60˚C then annealing is needed and steam conditioning is best. Unreinforced PA will change dimensionally by about 0.9% by volume for each % of moisture absorbed. PA parts will shrink after the moulding operation and then swell as moisture absorption takes place. The control of tolerances is therefore critically dependent on the moisture and the processing parameters. The absolute amount of

shrinkage that will take place is dependent on the processing parameters, the variant used, the filler content, the type of filler and the part geometry.

Extrusion

PA requires a properly designed screw to cope with the sharp melting point and low melt viscosity. Extruders must be able to keep the temperature profile constant to control the melt viscosity. High melt viscosity types of PA are preferred for extrusion.

Regrind (provided it is dry) can be used up to 30% without adverse effects.

Process selector

Processing Method	Applicable
Injection Moulding	Yes
Extrusion	Yes
Extrusion Blow Moulding	Yes
Injection Blow Moulding	Yes
Rotational Moulding	Yes
Thermoforming	Yes
Casting	Yes - PA 12
Bending and joining	Yes

8. Finishing

Machining

PA can be easily machined and the use of coolants allows high cutting speeds whilst still producing a good surface finish. Tools should be sharp and have good clearance and cutting angle.

Surface treatment

PA can be printed or hot-stamped without pre-treatment. PA can be electroplated, metallised or painted.

Welding

All processes suitable for thermoplastics can be used e.g., ultrasonic, friction, hotplate, high frequency and heat impulse welding. The hygroscopic nature of PA can affect welding performance. When PA is reinforced with glass fibre this can also make welding difficult.

Bonding

PA can be bonded with phenol or resorcinol-based adhesives, isocyanates or reactive adhesives.

9. Health and safety

PA does not constitute a health hazard but in food contact applications care must be taken in the choice of additives used.

10. Other information

Identification

PA is flammable and continues to burn when the source of ignition is removed.

The material bubbles and drips and threads can be pulled from the molten material.

The flame is blue and has the odour of burning horn.

11. Detailed chemical resistance for PA 6

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	NR	NR	ND
Acetic acid (10%)	R	NR	ND
Acetic acid (glac./anh.)	ND	NR	ND
Acetic anhydride	LR	ND	ND
Aceto-acetic ester	ND	ND	ND
Acetone	R	NR	ND
Other ketones	ND	ND	ND
Acetonitrile	ND	ND	ND
Acetylene	R	ND	ND
Acetyl salicylic acid	ND	ND	ND
Acid fumes	NR	NR	ND
Alcohols	R	ND	ND
Aliphatic esters	R	ND	ND
Alkyl chlorides	ND	ND	ND
Alum	R	ND	ND
Aluminium chloride	R	ND	ND
Aluminium sulphate	R	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	R	NR	ND
Antimony trichloride	NR	NR	ND
Aqua regia	NR	NR	ND
Aromatic solvents	ND	NR	ND
Ascorbic acid	ND	ND	ND
Beer	R	ND	ND
Benzaldehyde	LR	ND	ND
Benzene	R	ND	ND
Benzoic acid	LR	ND	ND
Benzoyl peroxide	ND	ND	ND
Boric acid	R	ND	ND
Brines, saturated	R	ND	ND
Bromide (K) solution	R	ND	ND
Bromine	NR	NR	ND
Bromine liquid, tech.	NR	NR	ND
Bromine water, saturated aqueous	NR	NR	ND
Butyl acetate	R	ND	ND
Calcium chloride	NR	NR	ND
Carbon disulphide	R	ND	ND
Carbonic acid	R	ND	ND
Carbon tetrachloride	NR	NR	ND
Caustic soda & potash	R	NR	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	ND	ND
Chloroacetic acid	NR	NR	ND
Chlorobenzene	R	NR	ND
Chloroform	R	NR	ND
Chlorosulphonic acid	NR	NR	ND
Chromic acid (80%)	NR	NR	ND
Citric acid	R	ND	ND
Copper salts (most)	R	ND	ND
Cresylic acids (50%)	NR	NR	ND
Cyclohexane	R	ND	ND
Detergents, synthetic	R	ND	ND
Emulsifiers, concentrated	ND	ND	ND
Esters	ND	ND	ND
Ether	R	ND	ND
Fatty acids (>C_6)	R	ND	ND
Ferric chloride	LR	ND	ND
Ferrous sulphate	LR	ND	ND
Fluorinated refrigerants	R	ND	ND
Fluorine, dry	NR	NR	ND
Fluorine, wet	NR	NR	ND
Fluorosilic acid	R	NR	ND
Formaldehyde (40%)	R	NR	ND
Formic acid	NR	NR	ND
Fruit juices	R	ND	ND
Gelatine	R	ND	ND

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

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Chemical	Resistance		
	20°C	60°C	100°C
Mercuric chloride	LR	ND	ND
Mercury	R	ND	ND
Methanol	ND	ND	ND
Methylene chloride	R	ND	ND
Milk products	R	ND	ND
Moist air	R	ND	ND
Molasses	R	ND	ND
Monoethanolamine	ND	ND	ND
Naptha	R	ND	ND
Napthalene	R	ND	ND
Nickel salts	R	ND	ND
Nitrates of Na, K and NH_3	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)	ND	ND	ND
Nitrobenzene	LR	ND	ND
Oils, diesel	R	ND	ND
Oils, essential	R	ND	ND
Oils, lubricating + aromatic additives	R	ND	ND
Oils, mineral	R	ND	ND
Oils, vegetable and animal	R	ND	ND
Oxalic acid	R	ND	ND
Ozone	R	NR	ND
Paraffin wax	R	ND	ND

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

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Chemical	Resistance		
	20°C	60°C	100°C
Sulphonic acids	NR	NR	ND
Sulphur	R	ND	ND
Sulphur dioxide, dry	LR	ND	ND
Sulphur dioxide, wet	ND	NR	ND
Sulphur dioxide (96%)	ND	NR	ND
Sulphur trioxide	LR	ND	ND
Sulphuric acid (<50%)	NR	NR	ND
Sulphuric acid (70%)	NR	NR	ND
Sulphuric acid (95%)	NR	NR	ND
Sulphuric acid, fuming	NR	NR	ND
Sulphur chlorides	ND	ND	ND
Tallow	R	ND	ND
Tannic acid (10%)	ND	ND	ND
Tartaric acid	R	ND	ND
Trichlorethylene	R	NR	ND
Urea (30%)	R	ND	ND
Vinegar	R	NR	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	R	ND	ND

12. Detailed chemical resistance for PA 6/6

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	R	ND
Acetic acid (10%)	R	NR	NR
Acetic acid (glac./anh.)	NR	NR	NR
Acetic anhydride	ND	ND	ND
Aceto-acetic ester	ND	ND	ND
Acetone	R	R	NR
Other ketones	R	ND	ND
Acetonitrile	ND	ND	ND
Acetylene	ND	ND	ND
Acetyl salicylic acid	ND	ND	ND
Acid fumes	NR	NR	NR
Alcohols	R	R	R
Aliphatic esters	R	ND	NR
Alkyl chlorides	R	ND	ND
Alum	R	R	R
Aluminium chloride	R	ND	ND
Aluminium sulphate	R	R	R
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	R	NR	NR
Antimony trichloride	ND	ND	NR
Aqua regia	NR	NR	NR
Aromatic solvents	R	R	R
Ascorbic acid	ND	ND	ND
Beer	R	R	R
Benzaldehyde	ND	NR	NR
Benzene	NR	NR	NR
Benzoic acid	R	NR	NR
Benzoyl peroxide	ND	ND	ND
Boric acid	R	R	R
Brines, saturated	R	R	R
Bromide (K) solution	R	ND	ND
Bromine	NR	NR	NR
Bromine liquid, tech.	NR	NR	NR
Bromine water, saturated aqueous	NR	NR	NR
Butyl acetate	R	ND	ND
Calcium chloride	ND	ND	NR
Carbon disulphide	R	ND	ND
Carbonic acid	R	R	ND
Carbon tetrachloride	R	ND	ND
Caustic soda & potash	R	R	R
Cellulose paint	ND	ND	ND
Chlorates of Na, K, Ba	R	R	ND
Chlorine, dry	NR	NR	NR

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Chemical	Resistance		
	20°C	60°C	100°C
Chlorine, wet	NR	NR	NR
Chlorides of Na, K, Ba	R	R	R
Chloroacetic acid	NR	NR	NR
Chlorobenzene	ND	ND	NR
Chloroform	NR	NR	NR
Chlorosulphonic acid	NR	NR	NR
Chromic acid (80%)	NR	NR	NR
Citric acid	ND	ND	NR
Copper salts (most)	R	R	R
Cresylic acids (50%)	NR	NR	NR
Cyclohexane	R	ND	ND
Detergents, synthetic	R	R	R
Emulsifiers, concentrated	R	R	R
Esters	R	ND	ND
Ether	R	ND	ND
Fatty acids (>C_6)	R	ND	ND
Ferric chloride	R	NR	NR
Ferrous sulphate	R	R	R
Fluorinated refrigerants	R	ND	ND
Fluorine, dry	NR	NR	NR
Fluorine, wet	NR	NR	NR
Fluorosilic acid	NR	NR	NR
Formaldehyde (40%)	R	R	NR
Formic acid	NR	NR	NR
Fruit juices	R	R	R
Gelatine	R	R	R

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

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Chemical	Resistance		
	20°C	60°C	100°C
Mercuric chloride	R	NR	NR
Mercury	R	R	R
Methanol	R	R	R
Methylene chloride	ND	ND	NR
Milk products	R	R	R
Moist air	R	R	R
Molasses	R	R	R
Monoethanolamine	ND	ND	ND
Naptha	R	ND	ND
Napthalene	R	ND	ND
Nickel salts	ND	ND	ND
Nitrates of Na, K and NH_3	R	R	ND
Nitric acid (<25%)	NR	NR	NR
Nitric acid (50%)	NR	NR	NR
Nitric acid (90%)	NR	NR	NR
Nitric acid (fuming)	NR	NR	NR
Nitrite (Na)	NR	NR	NR
Nitrobenzene	LR	ND	ND
Oils, diesel	R	R	R
Oils, essential	R	R	R
Oils, lubricating + aromatic additives	R	R	R
Oils, mineral	R	R	R
Oils, vegetable and animal	R	R	R
Oxalic acid	R	ND	ND
Ozone	R	ND	ND
Paraffin wax	R	R	R

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Chemical	Resistance		
	20°C	60°C	100°C
Perchloric acid	NR	NR	NR
Petroleum spirits	R	R	R
Phenol	NR	NR	NR
Phosphoric acid (20%)	NR	NR	NR
Phosphoric acid (50%)	NR	NR	NR
Phosphoric acid (95%)	NR	NR	NR
Phosphorous chlorides	ND	ND	ND
Phosphorous pentoxide	R	R	ND
Phthalic acid	R	NR	NR
Picric acid	R	NR	NR
Pyridine	R	ND	ND
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	NR	NR	NR
Sodium silicate	R	R	R
Sodium sulphide	R	ND	ND
Stannic chloride	R	ND	ND
Starch	R	R	R
Sugar, syrups & jams	R	R	R
Sulphamic acid	NR	NR	NR
Sulphates (Na, K, Mg, Ca)	R	R	R
Sulphites	ND	ND	ND

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

13. Detailed chemical resistance for PA 11

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

14. Detailed chemical resistance for PA 12

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

Chemical	Resistance		
	20°C	60°C	100°C
Glycerine	R	ND	ND
Glycols	R	ND	ND
Glycol, ethylene	LR	ND	ND
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%)	ND	ND	ND
Hydrochloric acid (conc.)	ND	ND	ND
Hydrocyanic acid	ND	ND	ND
Hydrofluoric acid (40%)	NR	ND	ND
Hydrofluoric acid (75%)	NR	ND	ND
Hydrogen peroxide (30%)	LR	ND	ND
Hydrogen peroxide (30 - 90%)	ND	ND	ND
Hydrogen sulphide	R	ND	ND
Hypochlorites	ND	ND	ND
Hypochlorites (Na 12-14%)	LR	ND	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)	ND	ND	ND
Maleic acid	ND	ND	ND
Manganate, potassium (K)	NR	ND	ND
Meat juices	ND	ND	ND

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

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

Plastics Data File – PA (Nylon)

Chemical	Resistance		
	20°C	60°C	100°C
Sulphonic acids	ND	ND	ND
Sulphur	R	ND	ND
Sulphur dioxide, dry	R	ND	ND
Sulphur dioxide, wet	NR	ND	ND
Sulphur dioxide (96%)	NR	ND	ND
Sulphur trioxide	NR	ND	ND
Sulphuric acid (<50%)	NR	ND	ND
Sulphuric acid (70%)	NR	ND	ND
Sulphuric acid (95%)	NR	ND	ND
Sulphuric acid, fuming	NR	ND	ND
Sulphur chlorides	ND	ND	ND
Tallow	ND	ND	ND
Tannic acid (10%)	ND	ND	ND
Tartaric acid	R	ND	ND
Trichlorethylene	LR	ND	ND
Urea (30%)	R	ND	ND
Vinegar	R	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	R	ND	ND