Nylon 66 Polyamide (PA66) – Technical Material Specification

1.0 Material Overview & Common Uses

Nylon 66 (PA66) is a semi-crystalline engineering thermoplastic produced by the polycondensation of hexamethylenediamine and adipic acid. It offers a high melting point, excellent mechanical strength, stiffness, and wear resistance, making it a preferred material for high-performance mechanical components.

- Commonly used for gears, bearings, bushings, wear pads, and structural parts in automotive, aerospace, industrial machinery, and consumer goods.
- Available in extruded rod, sheet, and tube forms, as well as injection-molded grades.
- Often reinforced with glass fiber (e.g., PA66-GF30) for increased stiffness and dimensional stability.

2.0 Core Technical Properties & Sizing

- Density: 1.14 g/cm³ (unfilled); 1.36–1.40 g/cm³ (30% glass-filled).
- Melting point: 255–265 °C (crystalline peak).
- Glass transition temperature (Tg): 50–80 °C (dry); drops to ~0 °C when saturated with moisture.
- Tensile strength: 80–90 MPa (dry); 50–60 MPa (conditioned at 50% RH).
- Elongation at break: 15–40% (dry); 50–100% (conditioned).
- Flexural modulus: 2.8–3.2 GPa (dry); 1.2–1.8 GPa (conditioned).
- Notched Izod impact strength: 40–60 J/m (dry); 80–120 J/m (conditioned).
- Hardness: Rockwell R118–R120 (unfilled); Shore D 85–90.
- Water absorption: 1.2–1.5% at 24 hours immersion; 8–9% saturation at 23°C.
- Coefficient of linear thermal expansion: 80–100 × 10^{-6} /°C (unfilled); 20–30 × 10^{-6} /°C (glass-filled).
- Standard rod diameters: 6 mm to 200 mm (tolerance h8/h9).
- Standard sheet thicknesses: 1 mm to 100 mm (tolerance ±0.1 mm for thin sheets, ±0.5 mm for thick).
- Maximum continuous service temperature: 80–120 °C (depending on load and environment).

3.0 Processing, Machinability & Application

Nylon 66 is readily machinable using conventional metalworking equipment, but its hygroscopic nature and low thermal conductivity require careful control of cutting parameters and cooling to prevent dimensional changes and surface melting.

- Use sharp, polished carbide or high-speed steel (HSS) tooling with positive rake angles (10–15°) to minimize heat generation.
- Recommended cutting speed: 150–300 m/min for turning; 50–100 m/min for milling.
- Feed rate: 0.1–0.3 mm/rev for turning; 0.05–0.15 mm/tooth for milling.
- Depth of cut: 0.5–3.0 mm for roughing; 0.1–0.5 mm for finishing.

- Use flood coolant or compressed air to dissipate heat; avoid water-based coolants if the part will be used in a dry environment (moisture absorption may cause swelling).
- For drilling, use a 118–135° point angle with a slow helix; peck drilling recommended for holes deeper than 3× diameter.
- Threading: use single-point threading or thread mills; avoid roll forming due to material spring-back.
- Welding: ultrasonic welding, hot plate welding, and spin welding are effective; joint design should include a shear joint or tongue-and-groove.
- Adhesive bonding: use cyanoacrylate, epoxy, or polyurethane adhesives after surface roughening and degreasing; avoid solvent-based adhesives that may cause stress cracking.
- Annealing: recommended for stress relief after machining; heat at 150–180 °C for 1–2 hours, then slow cool to room temperature.

4.0 Common Defects & Quality Control

- Reject if surface has visible cracks, crazing, or stress whitening under 5× magnification.
- Reject if moisture blisters or bubbles are present on the surface (indicates improper drying before processing).
- Reject if dimensional variation exceeds ±0.1 mm for critical features (e.g., bearing journals, gear teeth).
- Reject if out-of-roundness exceeds 0.05 mm for rod diameters under 50 mm.
- Reject if flatness deviation exceeds 0.2 mm per 300 mm for sheet stock.
- Reject if surface roughness Ra exceeds 1.6 µm for sealing surfaces; Ra 3.2 µm acceptable for general use.
- Reject if material shows signs of thermal degradation (discoloration, charring, or brittle fracture).
- Reject if glass-filled grades exhibit fiber exposure or poor fiber distribution visible under 10× magnification.

5.0 Storage, Handling & WHMIS Guidelines

- Store in a dry, climate-controlled environment at 15–25 °C and below 50% relative humidity to minimize moisture absorption.
- Keep material sealed in original packaging or in airtight containers with desiccant until ready for use.
- Shelf life: 2 years from date of manufacture when stored properly; after that, verify mechanical properties before use.
- Follow FIFO (First In, First Out) inventory rotation to prevent aging-related embrittlement.
- WHMIS classification: Not classified as hazardous under WHMIS 2015 (GHS) for solid form. Dust or fines from machining may be classified as combustible dust.
- Mandatory PPE during machining: safety glasses with side shields, cut-resistant gloves, and hearing protection. Use local exhaust ventilation to control airborne dust.
- In case of fire: use water fog, dry chemical, or CO_2 extinguisher. Avoid direct water stream on molten nylon (may cause splattering).
- Dispose of waste in accordance with local regulations; Nylon 66 is recyclable (resin code PA).