Hastelloy C276: Technical Material Specification for Industrial Fabrication

1.0 Material Overview & Common Uses

Hastelloy C276 is a wrought nickel-molybdenum-chromium superalloy with the addition of tungsten, designed to exhibit exceptional resistance to a wide range of corrosive environments, including strong oxidizing and reducing acids, chlorides, and wet chlorine gas. It is classified under UNS N10276 and is widely used in chemical processing, pollution control, pulp and paper manufacturing, and oil and gas extraction where severe corrosion conditions exist.

- Common applications include chemical reactor vessels, heat exchangers, piping systems, scrubbers, and valves handling aggressive media such as sulfuric acid, hydrochloric acid, and chlorine dioxide.
- Also used in pharmaceutical equipment, waste incineration systems, and marine engineering components requiring high pitting and crevice corrosion resistance.

2.0 Core Technical Properties & Sizing

- Density: 8.89 g/cm³ (0.321 lb/in³) at 20°C.
- Melting Range: 1325–1370°C (2417–2498°F).
- Tensile Strength (annealed): Minimum 690 MPa (100 ksi).
- Yield Strength (0.2% offset, annealed): Minimum 283 MPa (41 ksi).
- Elongation (annealed): Minimum 40% in 50 mm (2 in).
- Hardness (annealed): Typically 90 HRB maximum (Rockwell B).
- Standard product forms: Plate, sheet, bar, pipe, and fittings. Plate thicknesses from 3 mm to 50 mm, sheet from 0.5 mm to 6 mm, bar diameters from 6 mm to 300 mm.
- Tolerances per ASTM B575 (plate/sheet): Thickness tolerance ±0.005 inches for thicknesses under 0.187 inches; flatness tolerance 0.125 inches per foot for annealed plate.

3.0 Processing, Machinability & Application

Hastelloy C276 is considered moderately difficult to machine due to its high work-hardening rate and low thermal conductivity. Carbide tooling with positive rake angles and generous clearance is essential. Flood coolant with high-pressure delivery is required to dissipate heat and prevent work hardening. Cutting speeds should be reduced by 30–50% compared to standard stainless steels.

- Turning: Use C2 or C3 grade carbide inserts with a 0.015–0.030 inch nose radius. Speed: 60–100 SFM (surface feet per minute) for roughing, 80–120 SFM for finishing. Feed: 0.005–0.015 inches per revolution.
- Milling: Use 4-flute carbide end mills with 30–35 degree helix angle. Speed: 40–80 SFM. Feed: 0.002–0.005 inches per tooth. Climb milling preferred to reduce work hardening.
- Drilling: Use cobalt or carbide drills with a 135-degree split point. Speed: 20–40 SFM. Peck drilling cycles recommended to break chips and reduce heat buildup.
- Welding: Use GTAW (TIG) or GMAW (MIG) with ERNiCrMo-4 filler metal (AWS A5.14). Preheating not required but interpass temperature must be kept below 150°C (300°F). Use 100% argon shielding gas at 15–25 CFH. Post-weld heat

treatment is generally not required but solution annealing at 1120°C (2050°F) followed by rapid quench may be specified for maximum corrosion resistance.

- Forming: Material is ductile in the annealed condition. Minimum bend radius for cold forming is 2T (2x thickness) for sheet and 3T for plate. Hot forming at 870–1230°C (1600–2250°F) with subsequent annealing recommended for severe bends.

4.0 Common Defects & Quality Control

- Reject if surface cracks, laps, or seams are visible under 10x magnification or detectable by dye penetrant inspection (ASTM E165).
- Reject if surface pitting exceeds 0.005 inches (0.13 mm) in depth or 0.020 inches (0.5 mm) in diameter on any surface.
- Reject if plate flatness deviation exceeds 0.125 inches per foot (3.2 mm per 300 mm) for thicknesses under 0.187 inches (4.75 mm).
- Reject if any inclusion or non-metallic stringer longer than 0.010 inches (0.25 mm) is detected per ASTM E45 Method A.
- Reject if hardness exceeds 95 HRB in the annealed condition, indicating insufficient annealing or contamination.
- Reject if chemical composition deviates from UNS N10276 limits: Ni balance, Mo 15.0–17.0%, Cr 14.5–16.5%, Fe 4.0–7.0%, W 3.0–4.5%, Co ≤2.5%, Mn ≤1.0%, V ≤0.35%, Si ≤0.08%, C ≤0.01%, P ≤0.025%, S ≤0.010%.

5.0 Storage, Handling & WHMIS Guidelines

- Store in a dry, indoor environment with relative humidity below 60% to prevent surface oxidation. No direct contact with copper or brass to avoid galvanic corrosion.
- Shelf life is indefinite under proper storage conditions. Use FIFO (First In, First Out) inventory rotation to ensure traceability and prevent surface contamination from prolonged storage.
- WHMIS Classification: Not classified as a hazardous material in solid form. However, machining and welding generate dust and fumes that are hazardous.
- Hazardous decomposition products: Nickel oxide, chromium(VI) compounds, molybdenum oxides, tungsten oxides. These are respiratory sensitizers and suspected carcinogens.
- Mandatory PPE during processing: NIOSH-approved N95 or P100 respirator for dust/fume protection; safety glasses with side shields; cut-resistant gloves (ANSI A4 or higher) for handling sharp edges; flame-resistant clothing during welding.
- Ventilation: Use local exhaust ventilation (LEV) with a capture velocity of at least 100 ft/min at the source during all machining and welding operations. Maintain general ventilation at 10 air changes per hour.
- Spill and disposal: Collect machining chips and dust in sealed metal containers. Do not mix with other metals for recycling. Dispose as hazardous waste per provincial regulations (e.g., Ontario Regulation 347).