

1. Product Overview

C70600 (90/10 cupronickel) is a copper-nickel-iron alloy containing approximately 10% nickel and 1.0-1.8% iron, with the balance copper. It is one of the most important copper alloys for marine engineering, valued for its outstanding resistance to seawater corrosion, erosion and biofouling. The nickel and iron dissolve in the copper to form a single-phase alpha (f.c.c.) solid solution that is tougher and more corrosion-resistant than brass.

In seawater service, C70600 develops a thin, adherent and self-renewing oxide film enriched in copper, nickel and iron oxides. This film provides the alloy's characteristic resistance to general corrosion, pitting, impingement attack and sulfide corrosion. C70600 also releases trace copper ions at the surface, which inhibit the attachment of marine organisms - a natural anti-fouling property that reduces the need for chlorination and mechanical cleaning in seawater systems.

C70600 is supplied as seamless and welded condenser tube, seamless and welded pipe, plate, bar and fittings. It is the standard material for seawater piping on ships and offshore platforms, power-station condensers, desalination plant tubing and marine hardware.

1.1 Key Features

- Outstanding seawater corrosion resistance - superior to aluminum brass (C68700).
- Natural biofouling resistance: trace Cu release inhibits marine organism attachment.
- High erosion resistance at seawater velocities up to 3.0-3.5 m/s (vs 2.0-2.5 m/s for Al brass).
- Resistant to sulfide attack and polluted-water corrosion - where Al brass fails.
- Single-phase alpha solid solution: good ductility, toughness and weldability.
- Iron addition (1.0-1.8%) is critical: it strengthens the protective film and improves impingement resistance.
- Full heat-lot traceability with EN 10204 3.1 / 3.2 mill test certificates.
- Third-party inspection (SGS, BV, TUV) available on request.

1.2 Typical Applications

Application	Description
Seawater piping	Shipboard and offshore-platform seawater, firewater and cooling systems
Condenser tubing	Power-station surface condensers (especially polluted / sulfide water)
Heat exchangers	Refinery, petrochemical and multi-stage flash (MSF) desalination units
Marine hardware	Valves, pump bodies, shafts, flanges, fittings in seawater service
Offshore systems	Water injection lines, ballast water and produced-water handling
Hull sheathing	Cu-Ni cladding on ship hulls and offshore structures for anti-fouling
Aquaculture	Fish-cage mesh and netting - corrosion + anti-fouling in one material

1.3 At-a-Glance Specification

Attribute	Value
UNS designation	C70600 (90/10 cupronickel)
EN designation	CW352H (CuNi10Fe1Mn); DIN 2.0836
Alloy system	Cu-Ni-Fe, single-phase alpha solid solution
Product forms	Tube, pipe, plate, bar, fittings, wire
Tempers	Annealed (O61, OS025), light-drawn (H55)
Density	8.94 g/cm ³ (0.323 lb/in ³)
Conductivity	≈ 9% IACS
Melting range	1 100 – 1 150 °C
Thermal conductivity	≈ 40 W/(m·K)
Max seawater velocity	≈ 3.0 – 3.5 m/s
Max service temp.	200 °C continuous (pressure / structural)
Certificates	MTC EN 10204 3.1 / 3.2, SGS, BV, TUV
MOQ	500 kg per specification

Composition and property limits conform to ASTM B111 / B466. Exact values should be verified against the material test certificate (MTC) for each order.

2. Chemical Composition & Standards

C70600 is a copper-nickel-iron alloy. The nickel (9-11%) provides the fundamental seawater corrosion resistance by enriching the protective oxide film. The iron (1.0-1.8%) is not merely a strengthening element - it is critical to corrosion performance: iron dissolved in the alpha matrix is incorporated into the surface film, dramatically improving resistance to impingement and erosion-corrosion. Manganese (up to 1.0%) acts as a deoxidizer and improves hot workability. The resulting microstructure is a single-phase alpha (f.c.c.) solid solution, which gives the alloy its excellent ductility, toughness and weldability.

2.1 Chemical Composition (wt%)

Element	Symbol	Content (% mass)	Note
Copper (incl. Ag)	Cu	Remainder	Balance / matrix (≈ 86 – 88%)
Nickel (incl. Co)	Ni	9.0 – 11.0	Core corrosion-resistance element
Iron	Fe	1.0 – 1.8	Film strengthener; critical for impingement resistance
Manganese	Mn	≤ 1.0	Deoxidizer; improves hot workability
Zinc	Zn	≤ 1.0	Trace / impurity
Lead	Pb	≤ 0.05	Trace
Sulfur	S	≤ 0.02	Trace
Carbon	C	≤ 0.05	Trace

Composition limits conform to ASTM B111 / B466. The iron range (1.0-1.8%) is deliberately specified - do not accept material below 1.0% Fe for seawater service, as impingement resistance degrades sharply. Verify against the MTC for each heat lot.

2.2 Applicable Standards by Product Form

Product form	Common standards
Seamless condenser tube	ASTM B111/B111M; EN 12451 (CW352H); JIS H3300; GB/T 8890
Welded condenser tube	ASTM B543; EN 12452 (CW352H)
Seamless pipe / tube (general)	ASTM B466
Welded pipe	ASTM B467
Plate / sheet / strip	ASTM B122; EN 1652; GB/T 2040
Bar / rod	EN 12163; GB/T 4423 (as applicable)
Fittings	ASME B16.22 / B16.29; MSS SP-73 / SP-104

2.3 Seawater Alloy Comparison

Property	C70600 90/10 CuNi	C71500 70/30 CuNi	C68700 Al-brass
Ni content	9-11%	29-33%	0%
Seawater corrosion	Excellent	Excellent+	Very good (clean water)
Erosion / impingement	Very good	Excellent	Moderate
Sulfide / polluted water	Resistant	Resistant	Susceptible
Biofouling resistance	Yes (natural)	Yes (natural)	No
Max seawater velocity	3.0-3.5 m/s	3.5-4.5 m/s	2.0-2.5 m/s
Relative cost	Medium	Highest	Lowest
Best for	Balanced seawater service	High-velocity / severe service	Clean-water HX tubes

3. Physical, Thermal & Electrical Properties

The values below are typical room-temperature properties for C70600 in the annealed condition. The nickel and iron additions reduce electrical and thermal conductivity significantly compared to pure copper (C11000), but the thermal conductivity remains adequate for heat-exchanger service. C70600 is essentially non-magnetic. Values are representative; slight variations may occur between tube, plate and bar due to cold-work level and grain size.

Property	Symbol	Value	Unit
Density	ρ	8.94	g/cm ³
Melting point (solidus)	—	1 100	°C
Melting point (liquidus)	—	1 150	°C
Specific heat capacity	c_p	0.377	J/(g·K)
Thermal conductivity	λ	40	W/(m·K)
Thermal expansion coeff.	α	17.0	$\times 10^{-6} / K$
Electrical conductivity	σ	9	% IACS
Electrical resistivity	ρ	0.19	$\mu\Omega \cdot m$
Modulus of elasticity	E	140	GPa
Shear modulus	G	52	GPa
Poisson's ratio	ν	0.34	—
Magnetic permeability	μ	≈ 1.0	essentially non-magnetic
Max continuous service temp.	—	200	°C

Sources: ASTM B111/B466 property data; CDA alloy data sheet for C70600; Nickel Institute CuNi 90/10 data. Values are typical annealed at 20 °C unless noted.

4. Mechanical Properties by Temper

Mechanical properties depend on temper, grain size and cold-work level. The table below summarizes typical values for C70600 condenser tube and pipe per ASTM B111 / B466. C70600 is considerably tougher and stronger than aluminum brass (C68700) at the same temper, thanks to the solid-solution strengthening effect of nickel and iron. Annealed tempers (O61 / OS025) are preferred for expanded tube-to-tubesheet joints and formed components where ductility is needed. For pressure-containing design, always verify against the MTC and the applicable code (e.g. ASME BPVC, TEMA).

Temper	Tensile (typ.)	Yield 0.5% EUL (typ.)	Elong. (min.)	Hardness (typ.)
Annealed (O61)	275 – 360 MPa	110 – 150 MPa	≥ 35%	65 – 85 HV
Annealed grain (OS025)	275 – 360 MPa	110 – 150 MPa	≥ 30%	65 – 85 HV
Light-drawn (H55)	≥ 325 MPa	≥ 240 MPa	≥ 12%	90 – 110 HV

Yield is reported at 0.5% extension under load (EUL), the convention used in ASTM B111 for copper-alloy tube. Hardness in Vickers (HV). Values are indicative; verify against ASTM B111 / B466 specification limits and the MTC.

5. Product Forms & Size Range

C70600 is supplied in a wide range of product forms for seawater piping, heat-exchanger tubing and marine hardware. Custom lengths, end-finishing (plain, expanded, bevelled), U-bend forming and machined fittings are available on request.

5.1 Standard Size Range by Product Form

Form	Typical size range	Notes
Seamless condenser tube	OD 6 – 51 mm; wall 0.5 – 3.0 mm	ASTM B111; straight or U-bend
Welded condenser tube	OD 16 – 51 mm; wall 0.7 – 2.5 mm	ASTM B543; straight lengths
Seamless pipe (general)	OD 6 – 219 mm; wall 1.0 – 8.0 mm	ASTM B466; schedule pipe available
Welded pipe	OD 50 – 610 mm; wall 1.5 – 12 mm	ASTM B467; large-diameter seawater lines
U-bend tube	OD 12 – 38 mm; min. bend ≥ 2.5 × OD	Stress-relieved after bending
Plate / sheet	Thick. 1 – 50 mm; width ≤ 1 500 mm	For tubesheets, baffles, hull cladding
Bar / rod	Dia. 5 – 120 mm; length 1 – 6 m	For valves, shafts, fittings

5.2 End Finishing & Special Processing

- Straight tube lengths: 3 – 18 m (commonly 6 m / 12 m).
- Plain, squared, deburred or bevelled ends as specified.
- U-bends supplied stress-relieved, with bend thinning controlled per TEMA / customer drawing.
- ID cleaned and passivated for heat-exchanger service; ends capped for shipment.
- Hull-cladding plate supplied with specified surface finish and edge preparation.

5.3 Packaging

- Straight tube / pipe: bundled in wooden cases with separator strips and end caps.
- U-bends: nested in cradles with foam protection at bend areas.
- Plate: palletized with interleave paper, edge protection and steel strapping.
- Each bundle tagged with heat number, size, temper and quantity.
- Export seaworthy packing with moisture barrier and desiccant.

6. Tolerances, Finish & Quality Control

C70600 tube and pipe are produced and inspected to ASTM B111 (or B466 / B467 for pipe). Because C70600 is used in pressurized seawater systems where failure can be catastrophic, every lot is tested for dimensional accuracy, mechanical properties and, on request, for corrosion performance. Hydrostatic or pneumatic testing is performed on each tube.

6.1 Dimensional Tolerances (typical)

Parameter	Typical tolerance
Outside diameter	± 0.05 – 0.13 mm (ASTM B111/B466 class)
Wall thickness	± 8 – 10% of nominal wall
Length (straight)	+3 / -0 mm, or custom-cut to drawing
Straightness	≤ 1.5 mm in any 3 m length
Ovality (OD)	≤ half the OD tolerance
U-bend thinning	max 17% of nominal wall at bend (per TEMA)

6.2 Surface Finish & Cleanliness

- Smooth, bright-annealed or mill-finish ID and OD; free from cracks, laminations and deep scratches.
- ID cleaned of residual drawing lubricant; ends capped to maintain cleanliness for HX service.
- Plate and bar supplied with mill, brushed or polished finish as specified.
- Surface meets customer cleanliness specification (e.g. TEMA, refinery spec).

6.3 Quality Control Test List

Test	Standard / method	Frequency
Chemical analysis	ASTM E478 / ICP-OES	Each heat
Tensile / elongation	ASTM E8 / E8M	Each lot
Hardness (HV)	ASTM E92	Each lot
Hydrostatic / pneumatic test	ASTM B111/B466 (per spec.)	Each tube / pipe
Eddy-current test	ASTM E243 (non-destructive)	Each tube (on request)
Dimensional / ovality	Calipers / micrometers	Each tube / pipe
Grain size	ASTM E112	Each lot (OS025 temper)
Flaring / flange test	ASTM B111 tube test	Per specification
Corrosion test (optional)	ASTM B287 / customer spec.	On request

7. Corrosion Resistance & Service Conditions

C70600 is one of the most corrosion-resistant copper alloys available for seawater service. Its performance derives from the protective surface film - a complex oxide layer enriched in Cu, Ni and Fe that forms spontaneously in seawater and renews itself if damaged. The iron content in the alloy is critical: it is incorporated into the film and dramatically improves resistance to impingement and erosion-corrosion, which is why C70600 tolerates higher flow velocities than aluminum brass.

7.1 Corrosion Mechanisms & Performance

- General seawater corrosion: excellent; long-term corrosion rate typically < 0.025 mm/year in clean, flowing seawater.
- Pitting resistance: very good; the protective film self-heals if locally damaged.
- Impingement / erosion-corrosion: very good; tolerates seawater velocities up to 3.0-3.5 m/s (vs 2.0-2.5 for Al brass).
- Sulfide / polluted-water resistance: good; unlike Al brass, C70600 does not suffer rapid attack in sulfide-bearing seawater.
- Stress-corrosion cracking (SCC): resistant; not susceptible to ammonia SCC like brass.
- Galvanic compatibility: compatible with steel, other copper alloys and titanium; can be safely coupled in seawater systems with proper design.
- Crevice corrosion: low risk under normal flow conditions.

7.2 Biofouling Resistance

- C70600 releases trace copper ions at the surface in seawater, which are toxic to settling marine organisms (barnacles, mussels, algae).
- This natural anti-fouling effect reduces or eliminates the need for chlorination in seawater cooling systems.
- Biofouling resistance develops after an initial film-formation period of 4-12 weeks in service.
- Anti-fouling performance is maintained as long as the alloy surface is exposed to flowing seawater; stagnant conditions reduce effectiveness.
- Cu-Ni cladding (C70600) on ship hulls can reduce fuel consumption by maintaining a smooth, fouling-free surface.

7.3 Design Considerations & Service Limits

Recommended maximum seawater velocity for C70600 tubing is about 3.0-3.5 m/s - substantially higher than aluminum brass. For piping systems, velocities up to 3.5 m/s are acceptable in straight runs; reduce at bends and pumps. The recommended continuous service temperature is 200 °C for pressure and structural applications. Key design practices:

7.4 Design Practices

- Avoid prolonged stagnant conditions (deposit attack); design for continuous or intermittent flow.
- For pipe entries and pump discharges, use design velocity limits: 3.5 m/s straight pipe, 2.5 m/s at inlets/bends.
- Initial film formation: allow 4-12 weeks of normal flow for the protective film to mature before full design velocity is applied (consider staged commissioning).
- Weldability: C70600 can be TIG / MIG welded with matching Cu-Ni filler (ERCuNi); welds retain corrosion resistance if properly cleaned and pickled.
- Avoid direct contact with mercury, ammonia vapour or strong oxidizing acids in continuous service.
- For galvanic isolation from aluminium or stainless steel in seawater, use insulating flanges or sacrificial anodes.
- For extremely high-velocity or severe-service applications (e.g. > 3.5 m/s, abrasive-laden water), consider C71500 (70/30 cupronickel).

8. About Gnee Metal

Gnee Metal is a supplier of copper and copper-alloy products for export markets. Our ISO 9001 / 14001 / 45001 certified plants serve customers in North America, Europe, the Middle East and Southeast Asia with C70600 seamless and welded cupronickel tube, pipe, plate and bar for seawater piping, condenser and marine hardware applications.

We provide project-specific mill test certificates (EN 10204 3.1 / 3.2), third-party inspection by SGS / BV / TÜV, and value-added services including U-bend forming, tube-to-tubesheet preparation, pipe cutting and bevelling, hull-cladding plate supply and technical consultation. Contact us for a quote or for help selecting the right temper and specification for your service environment.

Item	Detail
Website	chinacopperalloys.com
Email	sales@gneemetal.com
Certificates	ISO 9001 / ISO 14001 / ISO 45001
Third-party	SGS, Bureau Veritas, TÜV