# Introduction to CuNi 90/10 and CuNi 70/30

## Chemical Compsition

The chemical composition of alloys 90/10 and CuNi 70/30 have been optimised in collaboration with our customers in order to maximize the behaviour of the metal under the most strigent conditions of seawater corroison. Additionally, CuNi 90/10 and CuNi 70/30 meet all requires of the most international standards.

## Comparison Table of International Standards for CuNi 90/10

| | Ni% | Fe% | Mn% | C% | Pb% | S% | P% | Zn% | Zr% | Other imp. | Cu% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CuNi 90/10** | 10.0-11.0 | 1.5-1.8 | 0.5-1.0 | max 0.05 | max 0.01 | max 0.005 | max 0.02 | max 0.05 | max 0.03 | max 0.10 Sn+Pb max 0.03 | Balance |
| **NFA 51 - 102** | 9.0-11.0 | 1.0-2.0 | 0.3-1.0 | max 0.05 | - | max 0.02 | - | max 0.5 | - | max 0.10 Sn+Pb max 0.05 | Balance |
| **DIN 17664 2.0872** | 9.0-11.0 | 1.0-2.0 | 0.5-1.0 | max 0.05 | max 0.03 | max 0.02 | max 0.02 | max 0.5 | - | max 0.30 | Balance |
| **DIN 86019 2.1972** | 9.0-11.0 | 1.5-1.8 | 0.5-1.0 | max 0.05 | max 0.03 | max 0.015 | max 0.02 | max 0.15 | max 0.03 | max 0.30 | Balance |
| **EEMUA 144 UNS 7060x** | 10.0-11.0 | 1.5-2.0 | 0.5-1.0 | max 0.05 | max 0.01 | max 0.02 | max 0.02 | max 0.20 | - | max 0.30 | Balance |
| **BS 2871 CN 102** | 10.0-11.0 | 1.0-2.0 | 0.5-1.0 | max 0.05 | max 0.01 | max 0.05 | - | - | - | max 0.30 | Balance |
| **NES 779** | 10.0-11.0 | 1.0-2.0 | 0.5-1.0 | max 0.05 | max 0.01 | max 0.05 | - | - | - | max 0.30 | Balance |
| **MIL-T-16420K C70600** | 9.0-11.0 | 1.0-1.8 | max 1.0 | max 0.05 | max 0.02 | max 0.02 | max 0.02 | max 0.50 | - | - | mini 86.5 |
| **ASTM B466 C70600** | 9.0-11.0 | 1.0-1.8 | max 1.0 | max 0.05 | max 0.02 | max 0.02 | max 0.02 | max 0.50 | - | - | Balance |
| **JIS H 3300 C7060** | 9.0-11.0 | 1.0-1.8 | 0.2-1.0 | - | max 0.05 | - | - | max 0.50 | - | - | Cu+Ni +Fe+Mn min 99.5 |

## Comparison Table of International Standards for CuNi 70/30

| | Ni% | Fe% | Mn% | C% | Pb% | S% | P% | Zn% | A1% | Bi% | B% | Si% | Other imp. | Cu% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CuNi 70/30** | 30.0-32.0 | 0.6-0.7 | 0.5-1.0 | max 0.05 | max 0.01 | max 0.005 | max 0.01 | max 0.05 | max 0.03 | max 0.002 | max 0.02 | max 0.05 | max 0.10 | Balance |
| **NFA 51 - 102** | 29.0-32.0 | 0.4-0.7 | 0.5-1.5 | max 0.06 | - | max 0.02 | - | max 0.5 | - | - | - | - | max 0.10 Sn+Pb max 0.05 | Balance |
| **DIN 17664 2.0882** | 30.0-32.0 | 0.4-1.0 | 0.5-1.5 | max 0.05 | max 0.03 | max 0.02 | max 0.02 | max 0.5 | - | - | - | - | max 0.30 | Balance |
| **BS 2871 CN 107** | 30.0-32.0 | 0.4-1.0 | 0.5-1.5 | max 0.06 | max 0.01 | max 0.08 | - | - | - | - | - | - | max 0.30 | Balance |
| **DGS 320** | 30.0-32.0 | 0.4-1.0 | 0.5-1.5 | max 0.06 | max 0.01 | max 0.02 | max 0.01 | - | - | max 0.002 | max 0.02 | - | max 0.30 | Balance |
| **NES 780** | 30.0-32.0 | 0.6-1.0 | 0.5-1.5 | max 0.06 | max 0.01 | max 0.02 | max 0.01 | - | max 0.03 | max 0.002 | max 0.02 | max 0.05 | max 0.30 | mini 66.5 |
| **MIL-T-16420K C71500** | 29.0-33.0 | 0.4-1.0 | max 1.0 | max 0.05 | max 0.02 | max 0.02 | max 0.02 | max 0.50 | - | - | - | - | max 0.50 | mini 65.0 |
| **ASTM B466 C71500** | 29.0-33.0 | 0.4-1.0 | max 1.0 | max 0.05 | max 0.02 | max 0.02 | max 0.02 | max 0.50 | - | - | - | - | max 0.50 | Balance |
| **JIS H 3300 C7150** | 29.0-33.0 | 0.4-1.0 | 0.2-1.0 | - | max 0.05 | - | - | max 0.50 | - | - | - | - | - | Cu+Ni +Fe+Mn min 99.5 |



ATHICAL
**Athical Engineering Pte Ltd**
**Tel:** +65 6863 3378 **Fax:** +65 6863 3398 **Email:** enquiry@athical.com **Website:** www.athical.com

# Introduction to CuNi 90/10 and CuNi 70/30

## Physical Properties

| Typical Values | Units | CuNi 90/10 | CuNi 70/30 |
|---|---|---|---|
| Density (20°C) | kg/m$^3$ | 8900 | 8900 |
| Electrical Resistivity (20°C annealed) | $\mu\Omega$.cm | 19 | 34 |
| Thermal Conductivity (20°C to 200°C) | W/m.°K | 50 | 30 |
| Coefficient of Expansion (20°C to 200°C) | C x 10$^{-6}$ | 17 | 16 |
| Modulus of Elasticity (20°C annealed) | Mpa | 126 000 | 126 000 |
| Annealing Temperature | °C | 760 - 800 | 760 - 820 |
| Melting Interval | °C | 1100 - 1150 | 1180 - 1240 |
| Magnetic Permeability (20°C annealed) | | 1.08 - 1.80 | < 1.05 |

## Mechanical Properties *(Annealed Temper)*

| Typical Values | Units | CuNi 90/10 | CuNi 70/30 |
|---|---|---|---|
| Tensile Strength (UTS),(Rm) | MPa | ≥ 310 | ≥ 350 |
| | ksi | ≥ 44 | ≥ 51 |
| Proof Stress (YS 0,2), (Rp 0,2) | MPa | ≥ 110 | ≥ 130 |
| | ksi | ≥ 16 | ≥ 19 |
| Elongation (E 5,65 √S) | % | ≥ 35 | ≥ 30 |
| Hardness (HB10 D$^2$) | | ≥ 70 | ≥ 80 |

## Mechanical Properties According to Temperature

| | °C / Units | -200 | -150 | -100 | -50 | 0 | 50 | 100 | 150 | 200 | 250 | 300 | 350 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CuNi 90/10 | | | | | | | | | | | | | |
| T.S | MPa | 450 | 390 | 330 | 310 | 300 | 300 | 290 | 280 | 270 | 260 | 250 | 230 |
| Y.S. | MPa | 150 | 145 | 140 | 130 | 100 | 100 | 100 | 95 | 90 | 85 | 80 | 65 |
| E (E 5,65 √S) | % > | | | | | 35 | 32 | 28 | 26 | 24 | 23 | 21 | 20 |
| CuNi 70/30 | ksi | | | | | | | | | | | | |
| T.S | MPa | 480 | 420 | 380 | 360 | 350 | 350 | 340 | 320 | 320 | 310 | 300 | 280 |
| Y.S. | MPa | 110 | 175 | 150 | 140 | 130 | 130 | 130 | 125 | 120 | 115 | 110 | 110 |
| E (E 5,65 √S) | % > | | | | | 30 | 28 | 24 | 23 | 22 | 20 | 19 | 18 |

Contrary to steels, CuNi 90/10 and CuNi 70/30 do not become fragile at low temperatures

## Maximum Permissible Stress According to Service Temperature as per ASME Code, Section III

| | °C / Units | 20 | 40 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CuNi 90/10 | MPa | 70 | 69 | 67 | 66 | 65 | 63 | 62 | 60 | 58 | 57 |
| CuNi 70/30 | MPa | 84 | 83 | 77 | 75 | 74 | 72 | 71 | 70 | 70 | 70 |

# Introduction to CuNi 90/10 and CuNi 70/30

## Working Pressures as per ASME Code, Section III *(Without Safety Coefficient)*

| Working Pressure | | |
|---|---|---|
| Tubes | Bar | |
| O.D. x W.T. | CuNi 90/10 | CuNi 70/30 |
| 10 x 1.0 | 152 | 183 |
| 12 x 1.0 | 125 | 150 |
| 16 x 1.0 | 92 | 111 |
| 16 x 2.0 | 194 | 233 |
| 20 x 1.0 | 73 | 88 |
| 20 x 2.0 | 152 | 183 |
| 25 x 1.5 | 88 | 106 |
| 25 x 2.0 | 120 | 144 |
| 30 x 1.5 | 73 | 88 |
| 30 x 2.5 | 125 | 150 |
| 38 x 1.5 | 57 | 68 |
| 38 x 2.5 | 97 | 117 |
| 44.5 x 1.5 | 48 | 58 |
| 44.5 x 2.5 | 82 | 99 |
| 57 x 1.5 | 38 | 45 |
| 57 x 2.5 | 64 | 76 |
| 76.1 x 2.0 | 38 | 45 |
| 76.1 x 2.5 | 47 | 57 |
| 88.9 x 2.0 | 32 | 38 |
| 88.9 x 2.5 | 40 | 48 |
| 108 x 2.5 | 33 | 40 |
| 108 x 3.0 | 40 | 48 |
| 133 x 2.5 | 27 | 32 |
| 133 x 3.0 | 32 | 39 |
| 159 x 2.5 | 22 | 27 |
| 159 x 3.0 | 27 | 32 |
| 159 x 3.5 | 31 | 38 |
| 193.7 x 2.5 | 18 | 22 |
| 193.7 x 3.0 | 22 | 26 |
| 193.7 x 3.5 | 26 | 31 |
| 219.1 x 3.0 | 19 | 23 |
| 219.1 x 3.5 | 23 | 27 |
| 219.1 x 4.0 | 26 | 31 |
| 219.1 x 4.5 | 29 | 35 |
| 267 x 3.0 | 16 | 19 |
| 267 x 4.0 | 21 | 25 |
| 267 x 4.5 | 24 | 29 |
| 267 x 5.5 | 29 | 35 |
| 323.9 x 4.0 | 17 | 21 |
| 323.9 x 5.0 | 22 | 26 |
| 323.9 x 5.5 | 24 | 29 |
| 323.9 x 7.0 | 31 | 37 |
| 368 x 4.0 | 15 | 18 |
| 368 x 5.5 | 21 | 25 |

| Working Pressure | | |
|---|---|---|
| Tubes | Bar | |
| O.D. x W.T. | CuNi 90/10 | CuNi 70/30 |
| 368 x 6.5 | 25 | 30 |
| 368 x 8.0 | 31 | 37 |
| 419.1 x 4.0 | 13 | 16 |
| 419.1 x 6.0 | 20 | 24 |
| 419.1 x 7.0 | 24 | 28 |
| 457.2 x 4.0 | 12 | 15 |
| 457.2 x 6.0 | 19 | 22 |
| 457.2 x 8.0 | 25 | 30 |
| 457.2 x 9.5 | 30 | 35 |
| 508 x 4.5 | 12 | 15 |
| 508 x 6.5 | 18 | 22 |
| 508 x 8.5 | 24 | 28 |
| 508 x 11.0 | 31 | 37 |
| 610 x 5.0 | 12 | 14 |
| 610 x 8.0 | 19 | 22 |
| 610 x 10.5 | 24 | 29 |
| 610 x 13.0 | 30 | 36 |
| 711 x 6.0 | 12 | 14 |
| 711 x 9.0 | 18 | 21 |
| 711 x 12.0 | 24 | 29 |
| 711 x 15.0 | 30 | 36 |
| 813 x 6.0 | 10 | 12 |
| 813 x 10.0 | 17 | 21 |
| 813 x 13.5 | 24 | 28 |
| 813 x 17.0 | 30 | 36 |
| 914 x 8.0 | 12 | 15 |
| 914 x 11.0 | 17 | 20 |
| 914 x 15.5 | 24 | 29 |
| 914 x 19.0 | 30 | 36 |

| Breaking Pressure | | |
|---|---|---|
| Tubes | Bar | |
| O.D. x W.T. | CuNi 90/10 | CuNi 70/30 |
| 25 x 1.5 | 410 | 450 |
| 30 x 1.5 | 380 | 420 |
| 38 x 1.5 | 320 | 350 |
| 44.5 x 1.5 | 260 | 270 |
| 57 x 1.5 | 180 | 200 |
| 76.1 x 2.0 | 180 | 200 |
| 88.9 x 2.0 | 175 | 190 |
| 108 x 2.5 | 165 | 180 |
| 133 x 2.5 | 145 | 160 |
| 159 x 2.5 | 125 | 135 |

Wall thickness calculation formula as per the ASME code : $\frac{2e}{Di} = \frac{P}{C\text{-}0.6P}$ or $\frac{P}{C} = \frac{2e}{Di + 1.2e}$

Maximum permissible stress (C).
In compliance with international standards
and main third party inspection organizations.

CuNi 90/10 : 70 N/mm$^2$
CuNi 70/30 : 84 N/mm$^2$

e = tube thickness
Di = tube inside diameter
C = maximum stress at working temperature
P = pressure difference between inside and outside of the tube

# Introduction to CuNi 90/10 and CuNi 70/30

## Corrosion Behaviour

CuNi 90/10 and CuNi 70/30 have an excellent behaviour when exposed to all forms of marine corrosion. This property is mainly due to the fact that the alloy prevents dissolution by forming a very strong protective surface film.

### CuNi 90/10 and CuNi 70/30 Possible Factors of Corrosion

| Corrosive Environment | Probable Corrosion | Behaviour In Service |
|---|---|---|
| Clean sea water circulation at a velocity of up to 1 m/s | Uniform Or General | 0.0025 - 0.025 mm/an |
| Clean sea water circulation at a velocity of up to 3.5 m/s* : CuNi 90/10 and 4.5 m/s* : CuNi 70/30 | Impact Corrosion | Satisfactory |
| Polluted Sea Water | General Corrosion and Accelerated Pitting Corrosion | Less Resistance |
| Deposits accumulated at the surface | Local Attack | Generally Good |
| Corrosion + stress | Stress Corrosion | Very Resistant |

* *the local speeds resulting from obstructions can be higher*

### Behaviour of CuNi 90/10 and CuNi 70/30 in the Presence of Sea Water, Brine and Sea Atmospheric Exposures

| Type of Corrosion | Behaviour |
|---|---|
| General Corrosion | Slightly sensitive to this type of corrosion<br>Corrosion rate is less than 25 $\mu$/year |
| Pitting Corrosion | Insensitive to this type of attack<br>Penetration rate less than 25/130 $\mu$/year |
| Selective Corrosion | Insensitive<br>Do not lose the alloying component like brasses and aluminium bronzes |
| Stress Corrosion | Never affected by this type of corrosion |
| Fouling Corrosion | Insensitive<br>Even at a low circulation speed, and although not affected by general corrosion, perfectly resist to the build-up of marine organisms |
| Corrosion-Erosion (impingement attack) | Very slightly sensitive<br>The addition of an optimum quantity of iron improves the nature of the protective film and makes the alloy very resistant to this type of aggression |

### Behaviour of CuNi 90/10 and CuNi 70/30 in Other Environments

- Good resistance in ammoniacal environment.
- The behaviour of copper nickel in the presence of crude petroleum is correct in the vapour phase, with however, the risk of the protective film being destroyed.

### Resistance of CuNi 90/10 to Fire

Test of resistance to fire have been made in simulating the service conditions of a pipeline during an offshore fire: piping empty - during 5 minutes - at 700°C, partly in the flame, then 15 minutes on water (with the start of the sprinklers).

They have shown the total reliabitiy of CuNi 90/10 : no rupture of the weld or of the brazing, no leakage, no permanent deformation.

After the end of the fire, the piping in CuNi 90/10 has needed no replacement.