Nickel-Copper Cu90/Ni10 Alloy

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Introduction

The Nickel-Copper Cu90/Ni10 alloy offers excellent resistance to the seawater and chloride solutions. It possesses high strength and superior welding character. The resistance to soil erosion and abrasive fluids is incomparable in the aqueous conditions.

Physical properties

Symbol	Melting range oC	Electrical conductivity at 20°C m/(Ω .mm^2)	Thermal conductivity at 20°C W/(m . K)	Coefficient of expansion (25 to 300°C) 10^{-6}/K	Elastic modulus EkN/mm^2
CuNi30	1170-1240	2.5	29	16	145

Chemical Constituents:

The Nickel-Copper Alloy consists of copper and nickel as the basic elements and with or without other elements such zinc may be present less than 1%. Besides of other elements, nickel is added in the highest concentration after copper.

Besides of 8.5% to 45% nickel, many industrial Nickel-Copper Alloys also comprise of manganese, iron and tin to enhance the certain features, moreover the casting alloys also comprise of niobium and silicon. The age hardenable Cu-Ni-Si alloys comprise of 1 – 4.5% nickel and 0.2 – 0.6% beryllium are often not chosen.
In the periodic table Cu and Ni are present consecutively and have relative weight. These two elements are closely related to each other and highly miscible in the liquid and solid forms. The Cu-Ni Alloy crystallizes at the different concentrations in the face centered cubic unit. The lattice space alters gradually with the content of nickel and copper.

Nickel

The pure nickel shows considerable effect on the physical and mechanical features of Cu-Ni alloys. The tensile strength, 0.2% proof strength, hot strength, solidification and liquefaction temperature and corrosion resistance improve with the addition of amount of nickel though the thermal and electrical conductivity reduce due to its performance. The tensile strength increases with an increase in content of nickel, expansion remains same after minor reduction in its content by 5%.

Manganese

The element Manganese is included to be liquefied for deoxidation. It holds sulphur that is recognized for hot processing as undamaging manganese sulfide enhances the casting features, increases strength, particularly the melting point.

Iron

The iron suspended in the solid mixture improves the resistance to corrosion property of **Nickel-Copper alloy**. It enhances the production of protected layer in the water so increases the corrosion resistance certainly in the rapidly flowing seawater. The miscibility of iron in the copper-nickel solid solution reduces with the decrease in temperature. These alloys containing significant amount of iron are age hardenable. The miscibility of iron is also based on the content of nickel such as it increases with an increase in the amount of nickel and becomes maximum when nickel is added by 30% and reduces further with increase in nickel content. The mechanical features are enhanced by adding iron. The cold processing is decreased.

Tin

The addition of tin increases the tensile strength; tarnish resistance and wear resistance of **Nickel-Copper alloy**, also an alloy consisting of 2% Sn is unique as it has excellent resistance to stress relaxation. Thus these alloys are utilized in making the spring components. The alloy with large concentration of Tin such as from 4% to 10% is an age hardenable material. With addition of silicon the castability increases and simultaneously it act as deoxidant. The solubility of silicon also improves with an addition of nickel. Besides of solubility, the amount of silicon also increases the strength and decreases ductility.

Niobium

Niobium improves the tensile strength and proof competency though the elongation decreases. The positive effect of this element is on the welding character of casting **Nickel-Copper alloys**.

Lead

The concentration of lead is kept low about 0.02% in the wrought alloys for hot processing. In fact the amount of lead higher than 0.01% disturbs the welding character of alloy. Although the casting alloys having lead up to 1-11% amount are widely considered for machining.

Phosphorous

Phosphorus has powerful embrittling influence on the copper nickel alloys and reduces the welding character due to cracking. So the amount of phosphorous is kept lower about 0.015% to 0.05%.

Mechanical Properties

The Cu90/Ni10 alloy offers high mechanical features at the elevated temperatures. The hot strength of copper enhances with the small amount of nickel. Nickel influences the molten cold treated **Copper-Nickel alloy** at the high temperatures. The addition of iron increases the mechanical properties at the room as well as high temperatures. Such copper-nickel alloy can be utilized in making the pressure vessel about 300oC to 350oC. With an increase in temperature, the strength decreases significantly, especially the creeping strength and strain limit.

Magnetism

The **Nickel-Copper alloys** do not show ferromagnetism. Copper shows diamagnetic nature and nickel shows ferromagnetic. The magnetic nature of nickel-copper alloys varies from diamagnetic to paramagnetic then ferromagnetic with the change in the concentration of nickel. On the base of alloy, iron shows nominal effect when it is kept in the solid solution. The precipitation of iron in the ferromagnetic microscopic particles leads to increase in ferromagnetism.

The precipitated free matrix remains diamagnetic or paramagnetic. The copper nickel alloys contain 20-25% nickel, 20% iron or 25% cobalt, are used for magnetic substance. Due to their remanence and coercive forces, these fit best for making the permanent magnets. The physical features of the wrought copper nickel alloys have been analyzed completely and these are significant from the room temperature to 1000oC.

Properties of Nickel-Copper Alloys

Property	Min.	Max	Units
Atomic Volume	0.0071	0.0073	M3/kmol
Density	8.5	8.95	Mg/m3
Energy Content	140	180	MJ/Kg
Bulk Modulus	130	170	GPa
Compressive Strength	85	550	Mpa
Ductility	0.03	0.44	
Elastic Limit	85	550	MPa
Endurance Limit	138	240	MPa
Hardness	580	1650	MPa
Shear Modulus	45	58	GPa
Melting Point	1384	1508	K
Resistivity	11.7	36.3	10-8 ohm.m
Poisson Ratio	0.34	0.35	
Modulus of Rupture	85	550	MPa

Applications of Nickel-Copper Alloys

Electronic Industry

The Copper-Nickel Cu90/Ni10 alloy is widely chosen in the electrical engineering for spring, relays, nominal current switch and plug joints.

It obtains exceptionally high relaxation features and best for using in these applications.

The Cu-Ni alloy is a quality spring material that can be utilized in the various operations like electromagnetic switches, navigation and measuring apparatus.

Sea Water

Specifically, the **Copper-Nickel alloy Cu90/Ni10** has become essential for making the ship components, power houses and heat exchanging device and seawater desalination houses. The Cu90Ni10 alloy is mainly purposeful for having low nickel amount for the economical operations and utilized in piping. The need of resistance to corrosion is more serious in ships that are made with condensers, and seawater lines are made of Copper-Nickel Cu90/Ni10 alloy.

Moreover the **Copper-Nickel Cu90/Ni10 alloy** is used as the preferable pipe material certainly in the dynamic seawater. This is also suitable in the various other solutions such as abrasive fluids. This alloy is more used due

to its high strength and resistance to corrosion. The cast Copper-Nickel Cu90/Ni0 alloys are used in the seawater quenching equipments of ships and chemical processing due to their tremendous resistance to the seawater and chloride solutions.

The Cu-Ni alloys are the specialized material to make the pipes for ships and harbour installation in the seawater, brackish water and deck steam streaks. These are also utilized for intake ships shafts, rings and discs for the hydraulic plants.

The valves, pumps, fitting, flanges, solver fitting and small components made of Cu-Ni alloys have been known to become the excellent material for ship parts due to excellent resistance to the seawater. The Cu-Ni alloys are also utilized in the firewater systems, lifeboat and more. The die forged parts of **Copper-Nickel Cu90/Ni10 tubing** are used in the production of T and bend parts of hydraulic equipments in the ships.

The **Copper-Nickel Cu90/Ni10 sheet** is utilized in the swimming batch heater, cooling condenser and oil coolers. The approved functionality of Cu-Ni alloy pipe in the marine operations has made it the best choice for offshore commerce.

In the various quenching circuits Copper-Nickel Cu90/Ni10 alloy are used as fitting materials. Therefore it is viable to utilize the material to obtain security from the corrosion and the production of galvanic pairs.

Due to the fouling inhibition features and excellent resistance in the water mediums, the Copper-Nickel Cu90/Ni10 alloy has strength for cladding. Avoiding the fouling and enhancing the tenderness of the ship hull, the significant amount of fuel can be saved at the same rate and maintenance costs can be reduced. The Copper-Nickel alloy Cu90/Ni10 cladding of platform legs to resist corrosion and fouling. In the marine operations the Copper-Nickel Cu90/Ni10 alloy is used in the evaporators and other components as thin dimpled sheet in the water chambers.
