ALLOY C-22

ALLOY C-22 (UNS N06022; W.Nr. 2.4602; NiCr21Mo14W) is a fully austenitic advanced corrosion resistant alloy that offers resistance to both aqueous corrosion and attack at elevated temperatures. This alloy provides exceptional resistance to general corrosion, pitting, crevice corrosion, intergranular attack, and stress corrosion cracking. ALLOY C-22 has found numerous applications in the chemical/petrochemical processing, pollution control (flue gas desulfurization), power, marine, pulp and paper processing, and waste disposal industries.

ALLOY C-22 is nickel-base and typically contains 22% chromium, 14% molybdenum, and 3% tungsten. Iron is normally limited to less than 3%. The alloy's high content of chromium gives it good resistance to wet corrosion by oxidizing media (e.g., nitric acid and ferric and cupric salts). Its contents of molybdenum and tungsten give the alloy resistance to wet reducing media (e.g., sulfuric and hydrochloric acids). ALLOY C-22 exhibits excellent resistance to corrosive attack by seawater under stagnant and flowing conditions.

At elevated temperatures, the high chromium level of ALLOY C-22 helps it resist oxidation, carburization, and sulfidation. Since it is nickel-base, ALLOY C-22 resists high temperature attack by halides (e.g., chlorides and fluorides). With these attributes, the alloy is widely used to protect steel tubes and other components in coal-fired and waste-to-energy boilers. ALLOY C-22 products are covered by ASTM, ASME and ISO specifications.

General Corrosion Resistance

The major attribute of ALLOY C-22 is outstanding resistance to a broad range of corrosive media. It resists oxidizing acids as well as reducing acids such as sulfuric and hydrochloric.

Some other corrosive chemicals to which the alloy has high resistance are oxidizing acid chlorides, wet chlorine, formic and acetic acids, ferric and cupric chlorides, sea water, brines and many mixed or contaminated chemical solutions, both organic and inorganic.

Localized Corrosion Resistance

Pitting and crevice corrosion are often evaluated by measurement of the minimum, or critical, temperature at which attack will occur. Critical pitting temperatures (CPT) and critical crevice temperatures (CCT) were determined in 6 wt. % ferric chloride + 1 wt. % hydrochloric acid at a maximum test temperature 85°C (185°F), Table 7. The relatively high molybdenum and tungsten and low iron content of ALLOY C-22 provide superior pitting resistance in this acid chloride environment.

Intergranular Corrosion

Intergranular attack (IGA) is a localized corrosive attack along the grain boundaries of an alloy product. While IGA can occur due to several mechanisms, precipitation of phases in the grain boundaries (sensitization) is the most common cause. Susceptibility to sensitization varies from alloy to alloy.

ALLOY C-22 has been shown to be resistant to sensitization when compared to most other corrosion resistant alloys.

The ASTM G28 tests are commonly used to verify the resistance of an alloy product to IGA. Corrosion data generated by test methods A and B are presented in Table 9. The method A procedure is the Streicher test while the method B test utilizes a modified "Green Death" medium. It is seen that ALLOY C-22 offers resistance equivalent to a competitive N06022 alloy.

Applications at Elevated Temperatures

While ALLOY C-22 is widely used for its excellent resistance to aqueous corrosion, the alloy is also resistant to many process environments at elevated temperatures up to 1250°F (677°C).

ALLOY C-22 has been found to be especially effective for protection of boiler tubes, waterwalls, and other components in coal-fired electric power generation boilers. The alloy has given superior service in low NOx boilers as well. ALLOY C-22 is resistant to attack at elevated temperatures by halides (especially chlorides) and sulfur, which are often present in the grades of coal used for power generation. ALLOY C-22 also offers excellent resistance to aggressive corrosion by metal chloride and sulfate salts found in power generation boilers fired by municipal solid waste. Alloy steel components are commonly overlaid with ALLOY C-22 by welding. Weld deposits fabricated using the Ni-Cr-Mo-W ALLOY C-22 do not exhibit the segregation tendencies shown by Ni-Cr-Mo-Nb alloy systems. This affords significant enhancements in corrosion resistance and excellent resistance to the corrosion fatigue cracking which is commonly observed in low NOx boiler waterwall overlays applied using Ni-Cr-Mo-Nb materials. In addition, solid components are used and ALLOY C-22 clad steel tubes are also available.

To meet stringent emission limits, fossil fuel and waste fired power generation boilers are being redesigned to add burners to limit the formation of oxides of nitrogen (NOx). Improved protection of the boiler tubes and waterwalls for service in these more aggressive environments is required. ALLOY 625 Filler Metal weld overlays have long been used for protection of such boiler components, but a recent study determined that these overlays can suffer from circumferential cracking due to stress-accelerated sulfidation of the dendrite centers of the weld overlays in as little as 18 months of service. The study also indicated that ALLOY 622 Filler Metal overlays should offer significantly better resistance to this attack and, thus, extended service life. This superior performance is attributed to the higher molybdenum content and the absence of niobium, which has been blamed for elemental segregation problems in ALLOY 625 weld overlays. As a result, ALLOY 622 welding products are preferred over ALLOY 625 products for overlay of boiler components.

Forming and Welding

ALLOY C-22 is readily fabricated by standard procedures for nickel alloys. Its high ductility aids cold forming, although work hardening may require intermediate annealing. Welding can be by gas tungsten-arc, gas metal-arc, and shielded metal-arc processes.

Hastelloy C22 is most Flexible Austenitic Tungsten added Nickel-Chrome-Molybdenum Alloy with increased resistance to stress, crevice & pittings corrosion. Most suitable alloy for chemical process applications in as-welded conditions. Alloy C22 has excellent overall general & localized corrosion resistance.

Hastelloy C22 **Chemical Composition (Typical)**

Element	Limit	
	min	max
Carbon	0.000	0.150
Manganese	0.000	0.500
Silicon	0.000	0.080
Sulphur	0.000	0.020
Phosphorus	0.000	0.020
Chromium	20.000	22.500
Molybdenum	12.500	14.500
Cobalt	0.000	2.500
Tungsten	2.500	3.500
Vanadium	0.000	0.350
Nickel	Remainder	

Mechanical Properties (Typical)

Parameter	Value
Yield 0.2 % (Mpa/Nmm^2), Min	310
Tensile (Mpa/Nmm2), Min	690
Elongation (% in 50MM), Min	45
Reduction Area(%), Min	--
Hardness (HRB), Max	95

Physical Properties

Parameter	Value
Density (Kg/m^3)	8690
Elastic Modulus (Gpa)	203
*Co-eff of Expansion (µm/m/°C)	12.4
*Thermal Condc. (W/m.K)	10.1
*Electric Resistivity (nΩ.m)	

*Note : @500°C

C22 Hastelloy Round Bar Equivalent Grades

STANDARD	UNS	WNR.	JIS	EN
Hastelloy C22	N06022	2.4602	NW 6022	NiCr21Mo14W

Material Specification Of Nickel Alloy C22 Round Bar

Nickel Alloy C22 Bar Grade	Hastelloy C22 – ALLOY C-22-UNS N06022 (Ni/ 22Cr/ 13Mo/ 3Fe/ 3W)
Standard	ASME, ASTM,
C22 Hastelloy Alloy Round bar Specification	ASTM B574 / ASME SB574 / AMS 5766 , ASTM B574 UNS N06022
Hastelloy C22 Round bar size	Diameter: 3-~800mm