Hastelloy C-4 Alloy

Heanjia Super Metals Co., Ltd

The **Hastelloy C-4 alloy** is a Nickel-Chromium-Molybdenum alloy that offers exceptional stabilization at the elevated temperatures, large ductility and resistance to corrosion and retains its characteristics even after aging up to 1200oF to 1900oF or 649oC to 1038oC. The alloy offers resistance to grain development precipitation in the welding area so it is highly suitable for the chemical processes in the welding condition. The C-4 alloy offers extremely high resistance to stress corrosion cracking and oxidizing conditions up to 1900oF or 1038oC.

Chemical composition % of Hastelloy C-4 Alloy

Ni	Co	Cr	Mo	Ti	Fe	Si	Mn	C	P	S
65	2.0	14 -18	14-17	0.70	3.0	0.08	1.0	0.01	0.025	0.010

Physical properties of Hastelloy C-4 alloy

Density	8.64 g/cm.3
Electrical Resistivity	1.25 microhm-m
Mean Coefficient of Thermal Expansion	10.8 x 10-6 m/m-K at 68-200oF
Thermal Conductivity	10.1 W/m-K at 74oF
Specific Heat	406 J/kg-K
Thermal Diffusivity	2.8 x 10-6 m2/s

The hardness and tensile properties offered by **Hastelloy C-4 high alloy** are shown below:

Alloy Form	Condition	Temp. oF & oC	Tensile Strength, MPa	Yield strength, MPa	Elongation %	Hardness, Rc
Sheet, 0.065 in (1.7 mm) thick	Heat-treated at at 1950oF (1066oC) quick cooling	400, 204	706	403	49	B-90
		600, 316	675	371	52	-
		800, 427	656	320	64	-
Sheet, 0.125 in (3.2 mm) thick	Heat-treated at at 1950oF (1066oC) quick cooling	600, 316	672	303	59	B-92
		800, 427	644	303	62	-
		1000, 538	645	299	55	-
Sheet, 0.156 in. (4.0 mm)	Heat-treated at at 1950oF (1066oC) quick cooling	600, 316	657	249	61	-
		800, 427	656	250	68	B-91

thick						

The dynamic modulus of elasticity at the different temperatures is provided below:

oF	oC	Gpa
200	93	211
400	204	207
600	316	201
800	427	194
1000	538	187

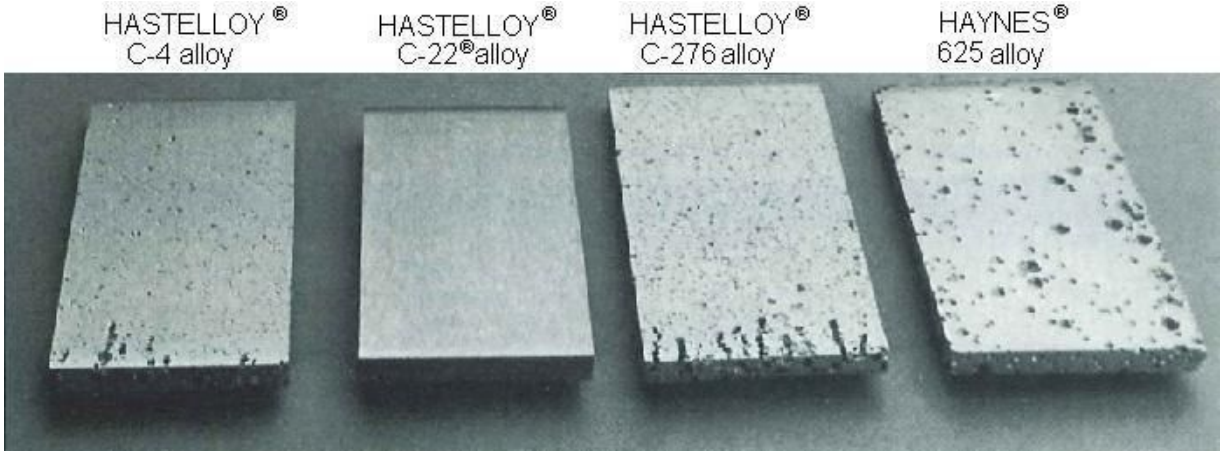
Formability of Hastelloy C-4 alloy

Form	**Condition**	**Average Olsen Cup Depth**	
Sheet, 0.065 in. (1.7 mm) thick	Heat-treated at at 1950°F (1066°C), rapid quench	0.52 inch	13.2 mm
	Aged 1000 hours at 1600°F (871°C)	0.52 inch	13.2 mm

Corrosion resistance

The **Hastelloy C-4 alloy** offers very high resistance to the different chemical processing conditions. These comprise of warm contaminated mineral acid, solvent, chlorine and chlorine mixed sources, arid chlorine, formic and acetic acid, acetic anhydride and seawater and brine mixtures and more.

The laboratory precipitation on the Hastelloy alloy shows that the intermetallic precipitation with the other nickel alloys at the temperature ranges of 1200 to 2000oF are not identified. The refined intergranular M6C carbide can be formed though with the minor destruction result. The accelerated analysis can be made to evaluate the resistance to corrosion offered by the hastelloy C-4 alloy. The analysis is made in the rigorous conditions that are even more rigorous than the normal industrial conditions.



The above image shows the extent of corrosion in the different Hastelloy C series alloys

Rate of Oxidation of Hastelloy C-4 Alloy

Test Temperature		Average Oxidation Rate per 100-hour test period - 100 hours, intermittent*	
oF	oC	mils	mm
1900	1038	0.16	0.004

The average corrosion rate **Hastelloy C-4 high temperature resistance alloy** is shown as following:

Medium	Weight	oF or oC	Average corrosion rate

			Unwelded, mm	As-welded, mm	Aged, mm
Formic Acid	20	Boiling	0.07	0.09	0.09
Hydrochloric Acid	10	167 or 75	0.91	0.86	0.89
Nitric Acid	10	Boiling	0.15	0.18	0.23
Phosphoric Acid	85	Boiling	1.5	1.30	2.20
Sulfuric Acid	10	167 or 75	0.56	0.64	0.51

The tensile properties of aged Hastelloy C-4 alloy sheet and plate:

Form	Condition	Temp		Tensile strength		Yield strength		Elongation
		oF	oC	Ksi	Mpa	Ksi	Mpa	%
Sheet, 0.125 in (3.2 mm) thick	Aged 100 hrs. at 1650°F(899°C)	400	204	103.2	712	47.1	325	54
		600	316	99.5	686	43.1	297	57
		800	427	97.0	669	40.6	280	60
		1000	538	93.3	643	39.9	275	57
		1200	649	86.6	597	37.2	256	56
Plate, 3/8 in (9.5 mm) thick	Aged 100 hrs. at 1650°F (899°C)	400	204	100.6	694	39.5	272	51
		600	316	98.0	676	37.0	255	56
		800	427	97.2	670	37.1	256	57
		1000	538	89.6	618	32.1	221	53
		1200	649	89.6	618	34.1	235	56

Ferric Sulfate Analysis- The Hastelloy C-4 material is evaluated for 24 hours period as per the ASTM G - 28A that includes boiling 50% sulfuric acid with 42 gm per liter of ferric sulfate. The grain precipitates provide high corrosion rate of alloy.

Stress Corrosion of Hastelloy C-4 Alloy

The stressed C-4 alloy materials were analyzed in the boiling 42 percent magnesium chloride that increases the corrosion attack. The Hastelloy C-4 alloy remains untouched for 1000 hours.

The **Hastelloy C-4 alloy** can be formed, hot stressed and impact extruded though it tends to be hardened to get easily deep drawn, spun, or punched. The popular welding techniques are used among of which the oxy acetylene and submerged arc techniques are not preferred due to the risk of corrosion.
