

NIMONIC® alloy 75 (UNS N06075/W.Nr. 2.4951 & 2.4630) is an 80/20 nickel-chromium alloy with controlled additions of titanium and carbon. First introduced in the 1940s for turbine blades in the prototype Whittle jet engines, it is now mostly used for sheet applications calling for oxidation and scaling resistance coupled with medium strength at high operating temperatures. It is still used in gas turbine engineering and also for industrial thermal processing, furnace components and heat-treatment equipment. It is readily fabricated and welded.

Table 1 - Limiting Chemical Composition, %
(as in BS HR 203)

Carbon	0.08-0.15
Chromium.....	18.0-21.0
Copper.....	0.5 max.
Iron.....	5.0 max.
Manganese	1.0 max.
Silicon	1.0 max.
Titanium.....	0.2-0.6
Nickel.....	Balance*

*Reference to the balance of the alloy composition does not guarantee this is exclusively of the element mentioned but that it predominates and others are present only in minimal quantities.

Physical Properties

Some physical properties for NIMONIC alloy 75 are given in Tables 2-4. Thermal expansion data in Table 3 were determined on fully heat-treated material. The data are subject to a variation of approximately $\pm 5\%$ according to processing variables. The dynamic modulus data in Table 4 were obtained from fully heat-treated cylindrical specimens vibrated in the flexural mode. The recommended heat treatments are quoted in the Heat Treatment section of this bulletin.

Table 2 - Physical Properties

Density*, Mg/m ³	8.37
lb/in ³	0.302
Melting Range, °C.....	1340-1380
°F	2450-2520
Specific Heat, J/kg•°C.....	461 at 20°C
Btu/lb•°F.....	0.110 at 68°F
Thermal Conductivity, W/m•°C.....	11.7 at 20°C
Btu•in/ft ² •h•°F	81.1 at 68°F
Electrical Resistivity, $\mu\Omega\cdot m$	1.09 at 20°C
$\Omega\cdot\text{circ}\cdot\text{mil}/\text{ft}$	.656 at 68°F

*Dependent on processing variables.

Table 3 - Mean Coefficient of Linear Thermal Expansion

°C	10 ⁻⁶ /°C	°F	10 ⁻⁶ /°F
20-100	11.0	68-200	6.0
-200	12.7	-400	7.1
-300	13.4	-600	7.5
-400	13.9	-800	7.8
-500	14.3	-1000	8.1
-600	15.0	-1200	8.4
-700	15.4	-1400	8.9
-800	16.5	-1600	9.4
-900	17.1	-1800	10.0
-1000	18.2		

Table 4 - Dynamic Young's Modulus

Temperature		GPa	10 ³ ksi
°C	°F		
20	68	221	32.1
100	212	216	31.3
200	392	210	30.5
300	572	203	29.4
400	752	197	28.6
500	932	190	27.6
600	1112	181	26.2
700	1292	173	25.1
800	1472	165	23.9
900	1652	153	22.2
1000	1832	140	20.3

Mechanical Properties

Tensile properties for bar are shown in Figure 1, and for sheet in Figure 2. Creep-rupture properties are shown by Larson-Miller presentation in Figure 3.

For all these tests, bar material was heat-treated for 30-60 minutes at 1050°C (1920°F) and air-cooled, and sheet material was heat-treated for 5-10 minutes at 1050°C (1920°F) and air-cooled.

Publication Number SMC-058

Copyright © Special Metals Corporation, 2004 (Sept 04)

NIMONIC, INCONEL, and MONEL are trademarks of the Special Metals Corporation group of companies.

The data contained in this publication is for informational purposes only and may be revised at any time without prior notice. The data is believed to be accurate and reliable, but Special Metals makes no representation or warranty of any kind (express or implied) and assumes no liability with respect to the accuracy or completeness of the information contained herein. Although the data is believed to be representative of the product, the actual characteristics or performance of the product may vary from what is shown in this publication. Nothing contained in this publication should be construed as guaranteeing the product for a particular use or application.



NIMONIC® alloy 75

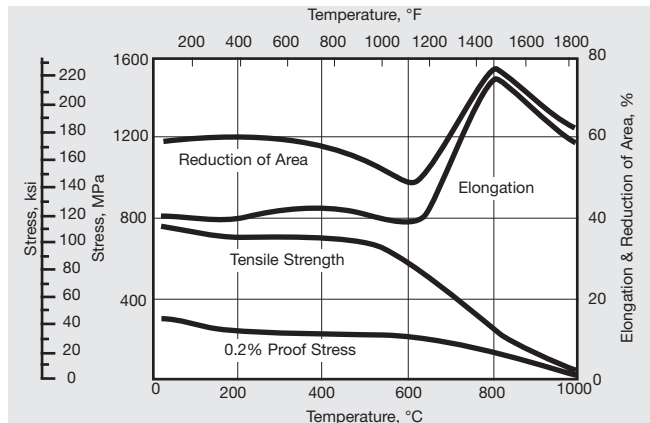


Figure 1. Tensile properties of NIMONIC alloy 75 bar.

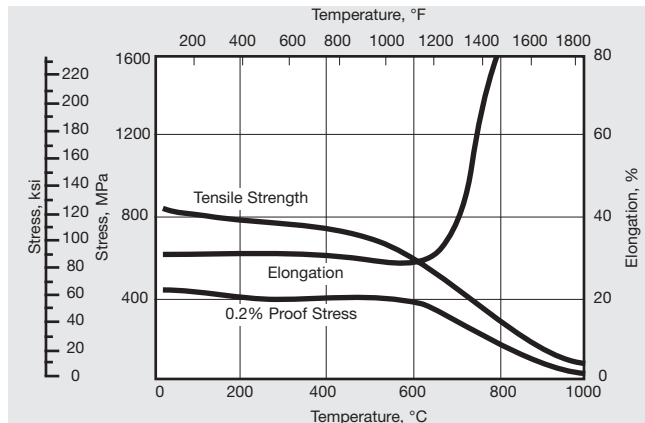


Figure 2. Tensile properties of NIMONIC alloy 75 sheet.

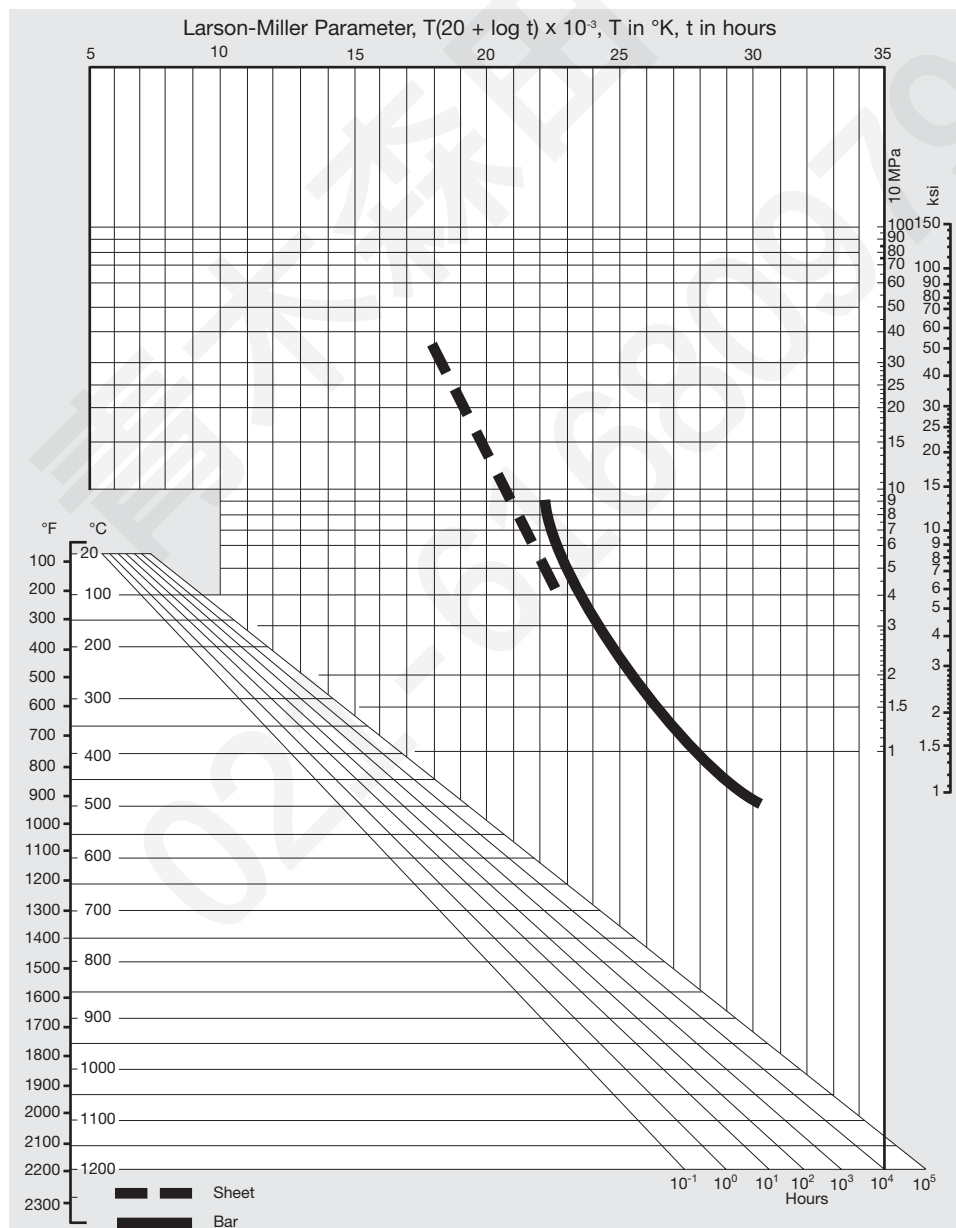


Figure 3. Creep-rupture properties of NIMONIC alloy 75 bar and sheet.

Corrosion Resistance

Oxidation resistance data are presented in Tables 5 and 6, and in Figure 4. For the continuous heating tests (Table 5), the specimens were oxidized in still air and the weight loss was determined after descaling electrolytically in NaOH.

Table 5 - Oxidation Resistance (Continuous Heating)

Alloy	Weight Loss (mg/cm ²) after 100 hours at				
	800°C (1470°F)	900°C (1650°C)	950°C (1740°F)	1000°C (1830°F)	1100°C (2010°F)
NIMONIC 75	0.55	1.18	4.00	6.66	8.92
NIMONIC 80A	0.64	2.62	3.96	5.96	11.20
NIMONIC 90	0.46	2.52	5.50	10.40	11.23
NIMONIC 105	0.11	0.49	0.99	1.43	6.49

Table 6 - Oxidation Resistance (Intermittent Heating*)

Alloy	Weight Loss (mg/cm ²) after 100 hours at			
	900°C (1650°F)	950°C (1740°F)	1000°C (1830°F)	1100°C (2010°F)
NIMONIC 75	2.25	4.61	4.68	14.1
NIMONIC 80A	2.75	8.92	9.06	20.2
NIMONIC 90	3.02	8.12	8.18	17.7
NIMONIC 105	1.19	1.54	-	13.3

*Cooled to room temperature every 24 hours.

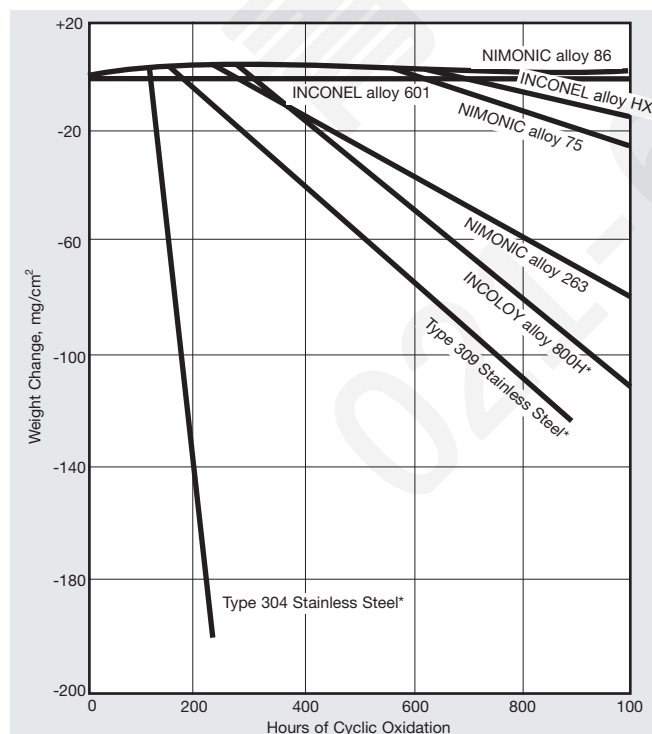


Figure 4. Cyclic oxidation resistance. Cycles of 20 minutes heating/5 minutes cooling except where marked * where the heating cycles were 15 minutes.

Metallography

NIMONIC alloy 75 has a stable, austenitic, solid solution at all temperatures below the solidus and, apart from recrystallization and grain growth, is unaffected by heat treatment. Typically, three phases are visible:

- 1) Oxide or silicate inclusions that arise from de-oxidation of the molten metal, visible in the polished condition as small, dark inclusions frequently present as stringers oriented in the principle working direction.
- 2) Intergranularly occurring primary carbides, nitrides or carbonitrides of the general type M(CN) where M is usually titanium. They are visible in the polished condition as substantially equiaxed, roughly spherical or cuboid inclusions whose color varies from white to purple for the carbide, to yellow for the nitride.
- 3) Chromium-rich grain boundary carbides, usually of the type M₂₃C₆. The carbides will dissolve into the matrix with heat, but at a temperature much higher than the normal annealing temperature.

Suitable etches for NIMONIC alloy 75 are:

- 1) A 4% aqueous solution of sulfuric acid used electrolytically at approximately 4V.
- 2) Fry's Reagent (4 g cupric chloride dissolved in 20 cm³ concentrated hydrochloric acid and 20 cm³ water).

Fabrication & Welding

NIMONIC alloy 75's work-hardening characteristics are compared with a range of other alloys in Figure 5.

Heat-Treatment

For bar 30-60 minutes at 1050°C (1920°F) followed by air cooling.

For sheet 5-10 minutes at 1050°C (1920°F) followed by air cooling or, before welding, 5-10 min/1050°C (1920°F)/AC + an optional 10 min/1050°C (1920°F)/AC.

Hot Working

NIMONIC alloy 75 can be hot worked in the range 1220-950°C (2230-1740°F).

Cold Working

The good ductility and malleability of annealed NIMONIC alloy 75 make it amenable to many methods of cold deformation. The alloy is subject to rapid strain hardening. Because of this increased strength, large reductions can be made without rupture.