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 ±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, μΩ•m	1.09 at 20°C
Ω•circ•mil/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

NIMONIC® alloy 75

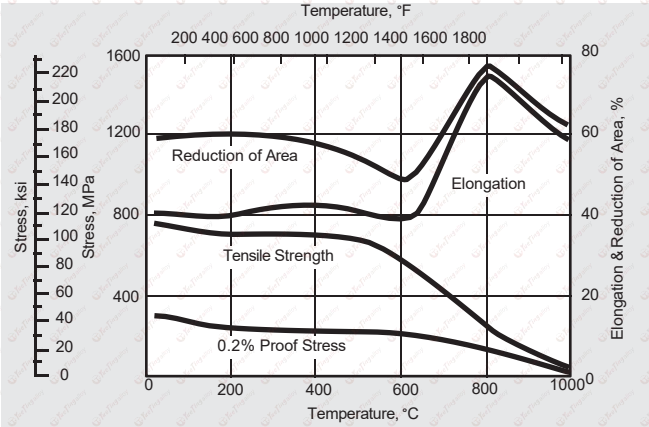

Figure 1. Tensile properties of NIMONIC alloy 75 bar.

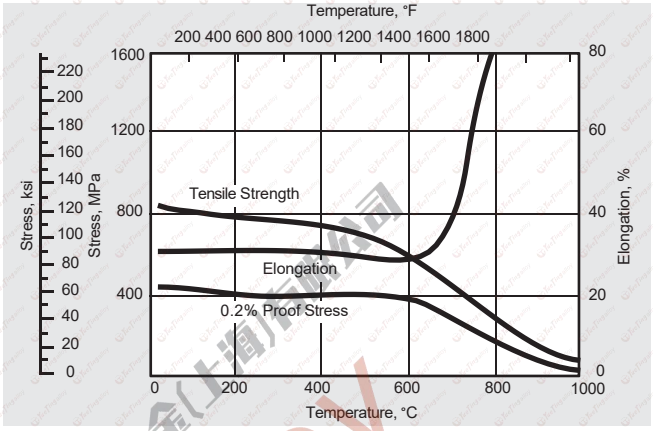

Figure 2. Tensile properties of NIMONIC alloy 75 sheet.

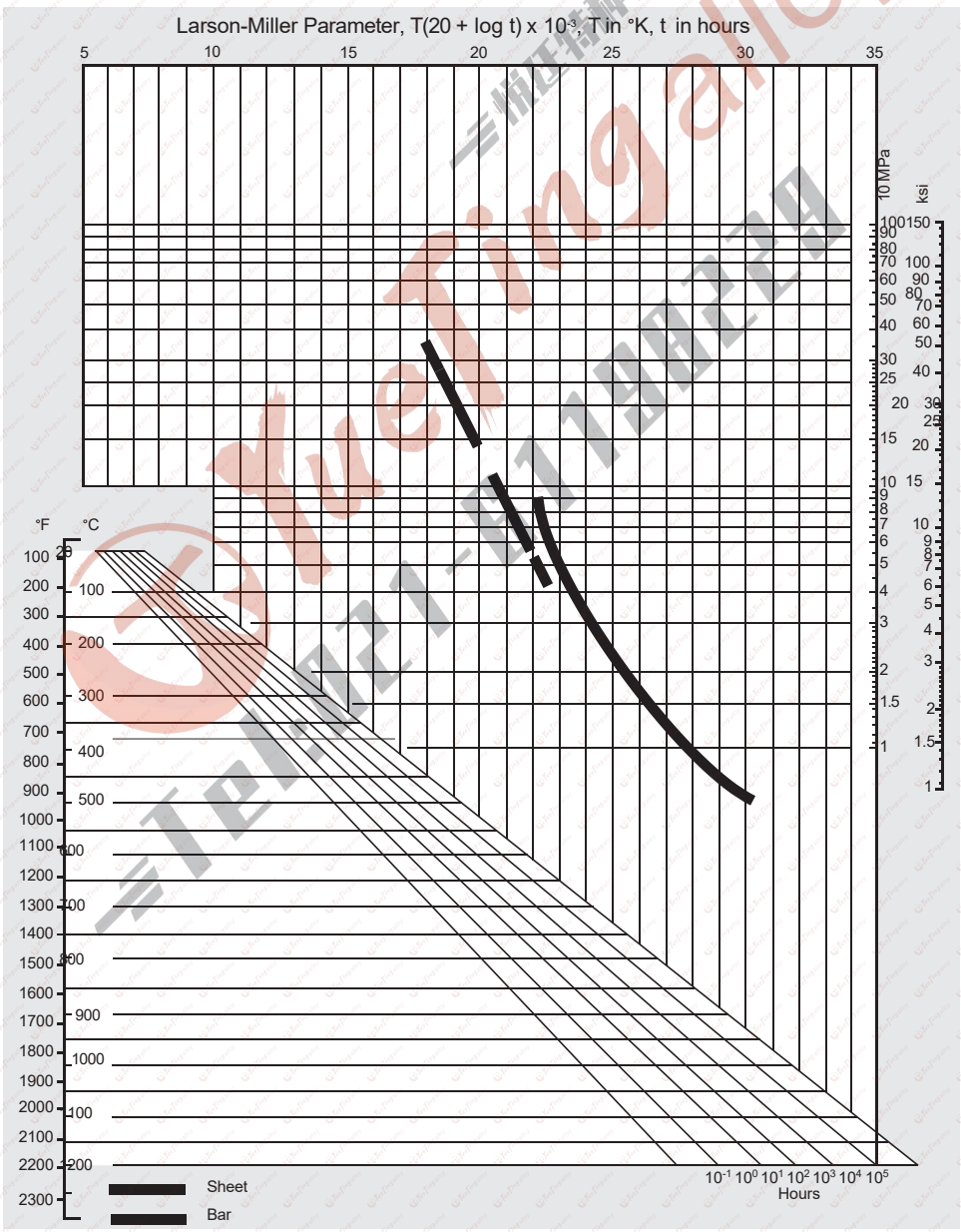

Figure 3. Creep-rupture properties of NIMONIC alloy 75 bar and sheet.

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/cm²) 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/cm²) 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.

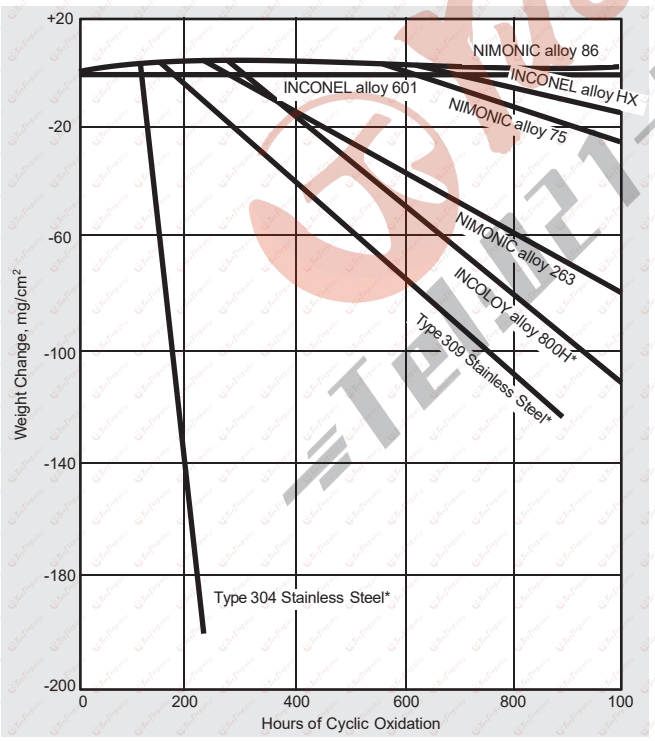

Figure 4. Cyclic oxidation resistance. Cycles of 20 minutes heating/5 minutes cooling except where marked * where the heating cycles were 15 minutes.

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 $M_{23}C_6$. 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.

SPECIAL METALS

www.yttzhj.com

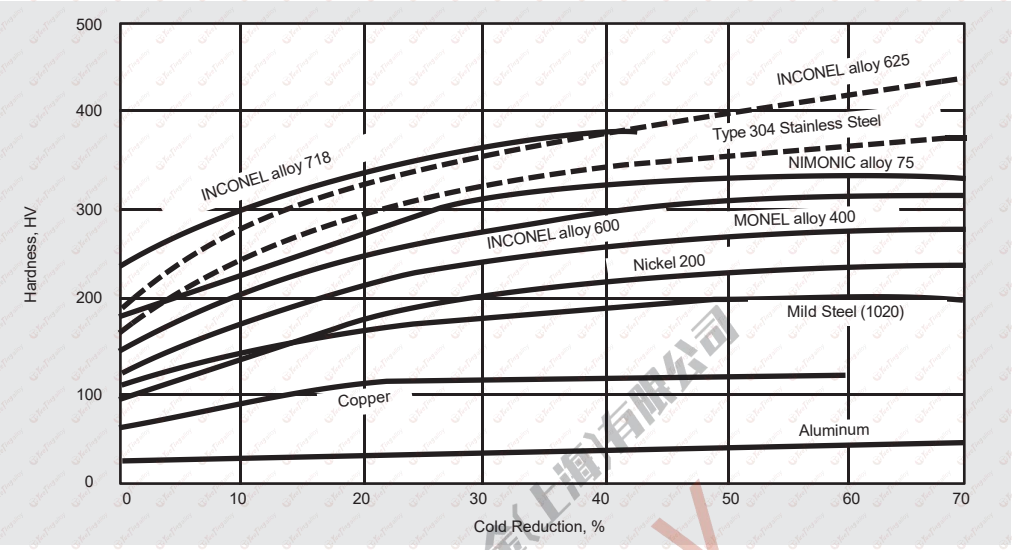

Figure 5. Effect of cold work on the hardness of various metals and alloys.

Welding

Material should be in the annealed condition before welding although a small amount of cold work is tolerable. The amount of permissible cold work varies with the component design but simple bending and rolling operations need not involve re-annealing prior to welding. The heat-affected zone produced in NIMONIC alloy 75 does not introduce weld decay and post-weld heat-treatment is not, normally, necessary. If equipment is required for service in contact with caustic soda, fluosilicates, or some mercury salts, a stress-relieving treatment could be desirable.

NIMONIC alloy 75 can be welded by the MMA, TIG, MIG and submerged-arc processes. Matched composition welding consumables are available from Special Metals Welding Products Co. The alloy is also amenable to electron beam, oxy-acetylene and resistance welding, and to brazing and soldering.

Available Products and Specifications

NIMONIC alloy 75 is designated as UNS N06075 and Werkstoff Numbers 2.4951 and 2.4630. Other designations include AFNOR NC20T, AICMA Ni-P91HT and DIN NiCr20Ti. Alloy 75 is available as sheet, strip, plate, round bar, forging stock, wire, tube and extruded section.

Rod, Bar, Wire and Forging Stock - BS HR 5, BS HR 504, DIN 17752, AECMA PrEN2306, AECMA PrEN2307, AECMA PrEN2402, ISO 9723-25

Plate, Sheet and Strip - BS HR 203, DIN 17750, AECMA PrEN2293, AECMA PrEN2302, AECMA PrEN2411, ISO 6208

Pipe and Tube - BS HR 403, DIN 17751, AECMA PrEN2294, ISO 6207

Other Product Forms - DIN 17742, AECMA PrEN2308