INCONEL® alloy 725 (UNS N07725) is a nickel-chromium-molybdenum-niobium alloy that is highly resistant to corrosion and is age hardenable for extremely high strength. It has essentially the same corrosion resistance as INCONEL alloy 625, which is widely used in a broad range of severely corrosive environments. The strength of age-hardened INCONEL alloy 725 is of the order of twice that of annealed alloy 625. Because the strength of alloy 725 is developed by heat treatment, not by cold work, ductility and toughness remain high. Also, strength can be imparted to large or non-uniform sections that cannot be strengthened by cold work.

The chemical composition of INCONEL alloy 725 is given in Table 1. High levels of nickel and chromium provide corrosion resistance in reducing and oxidizing environments. The substantial molybdenum content enhances resistance to reducing media and provides a high degree of resistance to pitting and crevice corrosion. Additionally, the combination of elements makes the alloy resistant to hydrogen embrittlement and stress-corrosion cracking.

The properties of INCONEL alloy 725 are useful for a range of applications that require outstanding corrosion resistance along with high strength. The alloy is used for hangers, landing nipples, side pocket mandrels and polished bore receptacles in sour gas service, where it resists the effects of hydrogen sulfide, chlorides and carbon dioxide. The alloy is also attractive for high strength fasteners in marine applications, where it resists corrosion, pitting and crevice attack in sea water.

Table 1 - Chemical Composition, %

Nickel	55.0-59.0
Chromium	19.0-22.5
Molybdenum	7.0-9.5
Niobium	2.75-4.0
Titanium	1.0-1.7
Aluminum	0.35 max.
Carbon	0.03 max.
Manganese	0.35 max.
Silicon	0.20 max.
Phosphorus	0.015 max.
Sulfur	0.010 max.
Iron	Balance*

*Reference to the 'balance' of a 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 representative physical properties of INCONEL alloy 725 are given in Table 2. Values for thermal expansion and electrical resistivity over a range of temperatures are listed in Table 3. Resistivity at elevated temperature was calculated from observed percent change in the room-temperature value. Modulus of elasticity, determined dynamically, is given in Table 4. All values for physical properties are for material in the age-hardened condition.

Table 2 - Physical Properties

Density, lb/in^3	0.300
g/cm^3	8.31
Melting Range, °F	2320-2449
°C	1271-1343
Permeability at 200 oersted (15.9 kA/m)	<1.001
Young's Modulus (70°F), ksi x 10^3	29.6
GPa	204
Shear Modulus (70°F), ksi x 10^3	11.3
GPa	78
Poisson's Ratio (70°F)	0.31

Table 3 - Thermal and Electrical Properties

Temperature	Coefficient of Expansion	Electrical Resistivity
°F	in/in-°F	ohm-cmil/ft
70	-	688.3
200	7.22	696.2
400	7.21	710.4
600	7.44	727.1
800	7.68	741.3
1000	7.79	758.6
1200	8.05	761.7
1400	-	776.1
1600	-	784.6
°C	µm/m-°C	µohm-m
20	-	1.144
100	13.0	1.158
200	13.1	1.179
300	13.4	1.206
400	13.7	1.226
500	14.1	1.251
600	14.4	1.265
700	-	1.273
800	-	1.302

[a]Mean coefficient of linear expansion between 70°F (21°C) and temperature shown.

Table 4 - Dynamic Modulus of Elasticity

Temperature	Young's Modulus	Shear Modulus	Poisson's Ratio
°F	ksi x 10^3	ksi x 10^3	
70	29.6	11.3	0.31
200	29.1	11.1	0.31
400	28.2	10.7	0.32
600	27.2	10.3	0.32
800	26.3	9.9	0.33
1000	25.4	9.6	0.32
1200	24.0	9.0	0.33
1400	22.5	8.4	0.34
1600	21.2	7.9	0.34

Temperature	Young's Modulus	Shear Modulus	Poisson's Ratio
°C	GPa	GPa	
20	204	78	0.31
100	200	76	0.32
200	194	74	0.31
300	188	71	0.32
400	182	69	0.32
500	177	67	0.32
600	169	63	0.35
700	160	61	0.32
800	150	56	0.33

Table 3a - Thermal Conductivity and Specific Heat Values for INCONEL alloy 725

Temperature, °C	Temperature, °F	Thermal Conductivity		Specific Heat	
		W/m K	BTU in/ft^2 h °F	J/kg °C	BTU/lb °F
23	73	10.631	73.76	430	0.103
93	200	11.724	81.34	446	0.107
100	212	11.827	82.06	447	0.107
149	300	12.666	87.88	457	0.110
200	392	13.544	93.97	468	0.112
204	400	13.615	94.46	469	0.113
260	500	14.491	100.54	481	0.115
300	572	15.122	104.92	489	0.117
316	600	15.390	106.78	492	0.118
371	700	16.346	113.41	503	0.121
400	752	16.843	116.86	508	0.122
427	800	17.284	119.92	511	0.123
482	900	17.920	124.33	517	0.124
500	932	18.152	125.94	519	0.125
538	1000	18.864	130.88	531	0.127
593	1100	19.912	138.15	550	0.132
600	1112	20.037	139.02	552	0.133
649	1200	21.205	147.12	577	0.139
700	1292	22.424	155.58	604	0.145
704	1300	22.453	155.78	604	0.145
760	1400	22.807	158.24	607	0.146
800	1472	23.062	160.01	609	0.146
816	1500	23.179	160.82	610	0.146
871	1600	23.596	163.71	615	0.148
900	1652	23.812	165.21	618	0.148
927	1700	24.226	168.08	624	0.150
982	1800	25.086	174.05	635	0.152
1000	1832	25.361	175.96	639	0.153
1038	1900	25.994	180.35	645	0.155
1093	2000	26.925	186.81	653	0.157
1100	2012	27.038	187.59	654	0.157
1149	2100	28.292	196.29	663	0.159
1200	2192	29.604	205.39	673	0.163

Mechanical Properties

In the age-hardened condition, INCONEL alloy 725 displays high strength along with excellent ductility and toughness. Mechanical properties over a range of temperatures are shown in Figures 1 and 2. Table 5 gives typical tensile properties, hardness, and impact strength for various product forms. The data in Table 6 indicate the good flattening properties of age-hardened tubing. Table 7 lists the average high-temperature tensile properties for annealed + aged bar, 0.625 to 6.5 inches (16 to 165 mm) diameter.

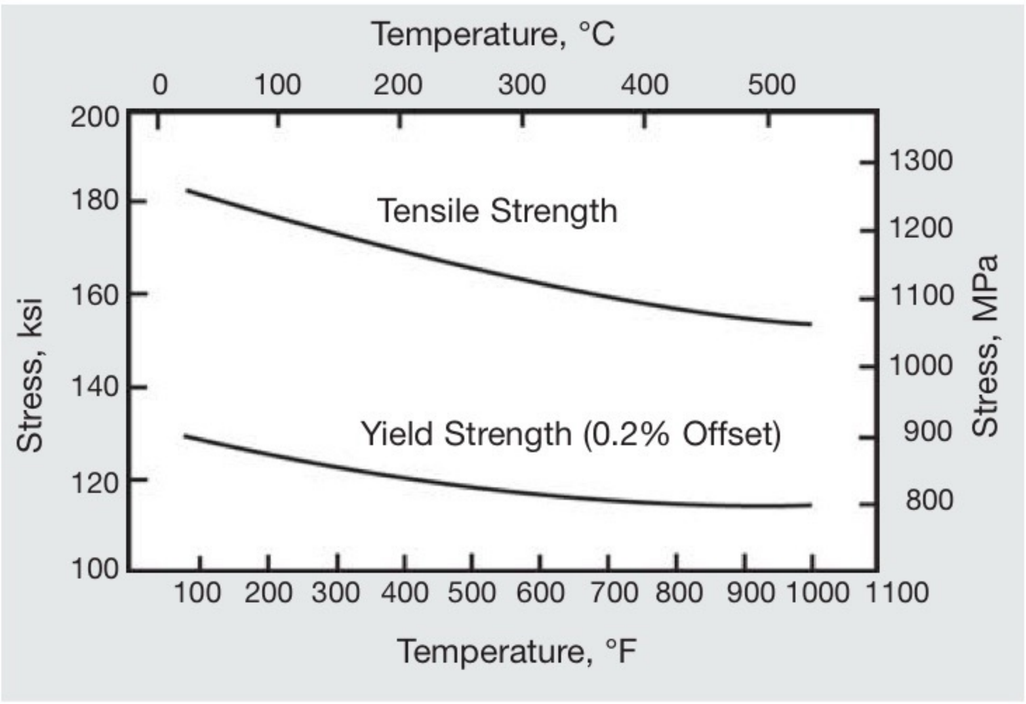

Figure 1. Tensile and yield strength of INCONEL alloy 725.

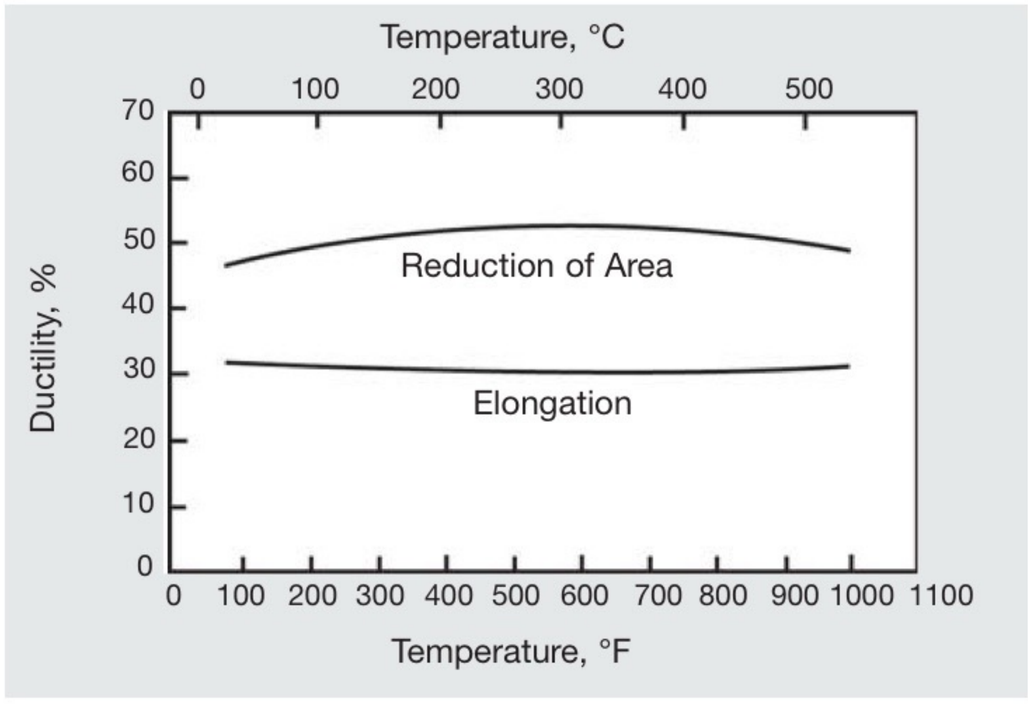

Figure 2. Elongation and reduction of area of INCONEL alloy 725.

Table 5 - Typical Room Temperature Mechanical Properties

Form	Condition	Yield Strength (0.2% Offset)		Tensile Strength		Elongation	Hardness	Charpy Impact	
		ksi	MPa	ksi	MPa	%	R_C	ft-lbf	J
Round[a]	Annealed	62.0	427	124.0	855	57	5	-	-
	Age Hardened	133.0	917	180.0	1241	30	36	68	92
Round[b]	Age Hardened	131.0	903	180.0	1241	31	36	97	132
Tube	Annealed	48.4	334	113.6	783	60	5	-	-
	Age Hardened	133.6	921	183.9	1268	27	39	-	-

[a]Transverse specimens from hot-finished rounds of 4.0 to 7.5 in (102 to 190 mm) diameter.
[b]Longitudinal specimens from hot-finished rounds of 0.5 to 7.5 in (13 to 190 mm) diameter.

Note: The above mechanical properties are “mean” values, and do not represent variances resulting from differences in thermo-mechanical processing.