Typical stress relieving and annealing cycles for wrought heat-resisting alloys

Alloy	Stress relieving			Annealing(a)		
	Temperature		Holding time per inch of section, h	Temperature		Holding time per inch of section, h
	°C	°F		°C	°F	
Iron-base and iron-nickel-chromium alloys						
19-9 DL	675(b)	1250(b)	4	980	1800	1
A-286	(c)	(c)	...	980	1800	1
Discaloy	(c)	(c)	...	1035	1900	1
Nickel-base alloys						
Astroloy	(c)	(c)	...	1135	2075	4
Hastelloy X	(c)	(c)	...	1175	2150	1
Incoloy 800	870	1600	1½	980	1800	¼
Incoloy 800H	...	...	...	1175	2150	...
Incoloy 825	...	...	...	980	1800	...
Incoloy 901	(c)	(c)	...	1095	2000	2
Inconel 600	900	1650	1	1010	1850	¼(d)
Inconel 601	...	...	...	980	1800	...
Inconel 625	870	1600	1	980	1800	1
Inconel 690	...	...	...	1040	1900	½
Inconel 718	(c)	(c)	...	955	1750	1
Inconel X-750	880(e)	1625(e)	...	1035	1900	½
Nimonic 80A	(c)	(c)	...	1080	1975	2
Nimonic 90	(c)	(c)	...	1080	1975	2
Rene 41	(c)	(c)	...	1080	1975	2
Udimet 500	(c)	(c)	...	1080	1975	4
Udimet 700	(c)	(c)	...	1135	2075	4
Waspaloy	(c)	(c)	...	1010	1850	4
Cobalt-chromium-nickel-base alloys						
L-605 (HS-25)	(f)	(f)	...	1230	2250	1
N-155 (HS-95)	(f)	(f)	...	1230	2150	...
S-816	(f)	(f)	...	1205	2200	1

(a) Minimum hardness is achieved by cooling rapidly from the annealing temperature, to prevent precipitation of hardening phases. Water quenching is preferred, and is usually necessary for heavy sections; air cooling is preferred for heavy sections of Waspaloy, Udimet 500, Udimet 700, and Inconel X-750, because water quenching causes cracking. However, for complex shapes subject to excessive distortion, oil quenching is often adequate and more practical. Rapid air cooling usually is adequate for parts formed from strip or sheet. Rapid cooling from the annealing or solution treating temperature does not suppress the aging reaction of some alloys, such as Astroloy; these alloys become harder and stronger. (b) Nominal temperature; 650 to 705 °C (1200 to 1300 °F) is permissable. (c) Full annealing is recommended, because intermediate temperatures cause aging. (d) Short time is required for prevention of grain coarsening. (e) Used only for stress equalizing of warm worked grades. (f) Full annealing is recommended if further fabrication is performed; otherwise, material can be stress relieved at approximately 55 °C (100 °F) below annealing temperature.

Source: Superalloys: A Technical Guide, Matthew J. Donachie and Stephen J. Donachie, ASM International, p 137, 2002.

INCONEL® nickel-chromium alloy 625 (UNS N06625/W.Nr. 2.4856) is used for its high strength, excellent fabricability (including joining), and outstanding corrosion resistance. Service temperatures range from cryogenic to 1800°F (982°C). Composition is shown in Table 1.

Strength of INCONEL alloy 625 is derived from the stiffening effect of molybdenum and niobium on its nickel-chromium matrix; thus precipitation-hardening treatments are not required. This combination of elements also is responsible for superior resistance to a wide range of corrosive environments of unusual severity as well as to high-temperature effects such as oxidation and carburization.

The properties of INCONEL alloy 625 that make it an excellent choice for sea-water applications are freedom from local attack (pitting and crevice corrosion), high corrosion-fatigue strength, high tensile strength, and resistance to chloride-ion stress-corrosion cracking. It is used as wire rope for mooring cables, propeller blades for motor patrol gunboats, submarine auxiliary propulsion motors, submarine quick-disconnect fittings, exhaust ducts for Navy utility boats, sheathing for undersea communication cables, submarine transducer controls, and steam-line bellows. Po-

The outstanding and versatile corrosion resistance of INCONEL alloy 625 under a wide range of temperatures and pressures is a primary reason for its wide acceptance in the chemical processing field. Because of its ease of fabrication, it is made into a variety of components for plant equipment. Its high strength enables it to be used, for example, in thinner-walled vessels or tubing than possible with other materials, thus improving heat transfer and saving weight. Some applications requiring the combination of strength and corrosion resistance offered by INCONEL alloy 625 are bubble caps, tubing, reaction vessels, distillation columns, heat exchangers, transfer piping, and valves.

In the nuclear field, INCONEL alloy 625 may be used for reactor-core and control-rod components in nuclear water reactors. The material can be selected because of its high strength, excellent uniform corrosion resistance, resistance to stress cracking and excellent pitting resistance in 500°-600°F (260-316°C) water. Alloy 625 is also being considered in advanced reactor concepts because of its high allowable design strength at elevated temperatures, especially between 1200°-1400°F (649-760°C).

The properties given in this bulletin, results of extensive testing, are typical of the alloy but should not

alloy 625