

INCOLOY alloy 25-6HN is a super-austenitic stainless steel containing 6% molybdenum. The alloy's properties are enhanced by its content of nitrogen. Its high content of nickel results in thermal stability and resistance to stress corrosion cracking. Designated as UNS N08367, alloy 25-6HN directly competes with similar super-austenitic stainless steels. Alloy 25-6HN is a new addition to Special Metals existing line of high performance, super-austenitic stainless steels, INCOLOY alloys 25-6MO and 27-7MO. The chemical composition of alloy 25-6HN is reported in Table 1.

Alloy 25-6HN offers significantly improved strength and corrosion resistance in most environments over conventional austenitic stainless steels such as AISI 304 and 316L. Typical applications include welded tubes for heat exchangers for chemical processing and marine applications and for desalination systems, plate and sheet for flue gas desulfurization equipment for coal-fired power plants and plate for reaction vessels for pharmaceutical production.

**Table 1: Chemical Composition**

Element	UNS N08367	INCOLOY alloy 25-6HN
C	0.03 max	0.01
Mn	2.00 max	0.4
P	0.040 max	0.02
S	0.030 max	0.001
Si	1.00 max	0.3
Cr	20.00-22.00	20.6
Ni	23.50-25.50	24.3
Mo	6.00-7.00	6.3
N	0.18-0.25	0.21
Cu	0.75 max	0.25
Fe	Bal.	Bal.

## Physical Properties

Some physical properties of alloy 25-6HN are reported in Table 2. Alloy 25-6HN is non-magnetic even at very low temperatures. The low density of alloy 25-6HN enhances its value over the more dense nickel-base alloys such as INCONEL alloys C-276, 22, and 686.

**Table 2: Selected Physical Properties**

Density	8.02 g/cm <sup>3</sup>
	0.290 lb/in <sup>3</sup>
Melting Range	2470-2560°F
Magnetic Permeability (200 Oersteds at RT)	1.003
Coefficient of Thermal Expansion (68-212° F)	8.49 in/in•°F x 10 <sup>-6</sup>

**Table 3: Coefficient of Thermal Expansion**

Temp. (°F)	Coefficient of Thermal Expansion 10 <sup>-6</sup> in/in•°F	Temp. (°C)	Coefficient of Thermal Expansion μm/m•°C
77	-	25	-
200	8.66	100	15.59
400	8.80	200	15.83
600	8.90	300	15.98
800	9.05	400	16.23
1000	9.21	500	16.45
1200	9.53	600	16.91
1400	9.77	700	17.35
1600	9.94	800	17.72

<sup>2</sup>"INCONEL", "INCOLOY", "INCO-WELD" and "686CPT" are trademarks of the Special Metals family of companies.

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## Mechanical Properties

INCOLOY alloy 25-6HN offers higher strength than conventional austenitic stainless steels and typical of other super-austenitic stainless steels as is seen in Table 4. Even with its high level of strength, the alloy offers excellent ductility for enhanced formability.

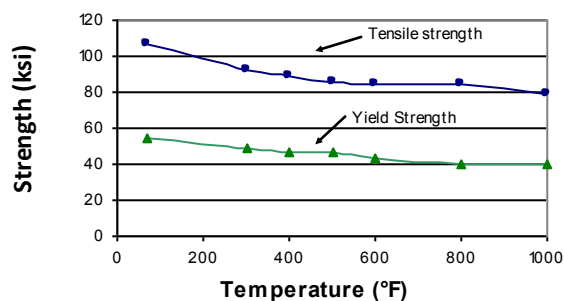
**Table 4: Typical Room Temperature Tensile Properties**

	25-6HN	25-6MO
Hardness	90 HRB	89 HRB
2% Yield Strength	55 ksi	52 ksi
Ult. Tensile Strength	107 ksi	109 ksi
Elongation	48%	47%

**Table 5: Typical Elevated Temperature Tensile Properties**

Temp. (°F)	Property	25-6HN
77	Yield Strength (ksi)	55
	Tensile Strength (ksi)	107
	Elongation (%)	48
300	Yield Strength (ksi)	49
	Tensile Strength (ksi)	93
	Elongation (%)	47
400	Yield Strength (ksi)	46
	Tensile Strength (ksi)	89
	Elongation (%)	47
500	Yield Strength (ksi)	46
	Tensile Strength (ksi)	86
	Elongation (%)	47
600	Yield Strength (ksi)	43
	Tensile Strength (ksi)	87
	Elongation (%)	46
800	Yield Strength (ksi)	40
	Tensile Strength (ksi)	84
	Elongation (%)	45
1000	Yield Strength (ksi)	43
	Tensile Strength (ksi)	80
	Elongation (%)	48

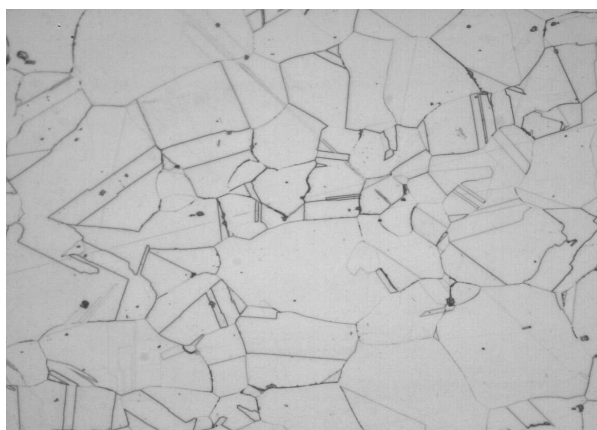
**Figure 1: Effect of Temperature on Strength**



## Microstructure

INCOLOY alloy 25-6HN exhibits a fully austenitic structure. The microstructure is especially “clean” due to proprietary deoxidation practices during melting. Thus, banding and stringers in alloy 25-6HN products are minimized. The structure of alloy 25-6HN plate is seen in Figure 2.

**Figure 2: Microstructure**



Etched in 2% Bromine Solution, Grain Size: ASTM No. 6

## Corrosion Resistance

INCOLOY alloy 25-6HN offers resistance to many modes of attack in a variety of aggressive environments. It is especially resistant to localized attack (crevice and pitting corrosion) in acid / halide media. Alloy 25-6HN also resists microbially-induced corrosion. With 25% nickel, the alloy is much more resistant to chloride-induced stress corrosion cracking than austenitic stainless steels (AISI 300 grades).

**INCOLOY® alloy 25-6HN**

Critical Pitting Temperatures (CPT) and Critical Crevice Temperatures (CCT) for super-austenitic stainless steels and nickel-base alloys are reported in Tables 6 & 7. The values for CPT and CCT of welded alloys are strongly influenced by the choice of filler material. While alloy 25-6HN is normally joined with INCONEL filler metal 625, higher CPT values can be obtained with the more-resistant INCO-WELD 686CPT filler metal (Table 8). Annealing after fabrication can also have a positive influence on the corrosion resistance of welded components.

**Table 6: ASTM G48 Corrosion Testing**

Alloy	Critical Pitting Temp. ASTM G48-C	Crevice Corrosion Temp. ASTM G48-D	PREN*
316 Stainless	20 C	<0	23.6
INCOLOY alloy 25-6MO	70 C	35 C	47.7
INCOLOY alloy 25-6HN	75 C	35 C	47.7
INCOLOY alloy 27-7MO	>85 C	50 C	53.2
INCONEL alloy 625	>85 C	35 C	53.4
INCONEL alloy C-276	>85 C	50 C	69.7
INCONEL alloy 686	>85 C	>85 C	74.7

\*PREN = %Cr+3(%Mo)=1.5(%Nb+%W)+30(%N)

**Table 7: Corrosion Testing in Green Death Solution**

Alloy	Critical Pitting Temp in Green Death Duration is 72 hrs	Crevice Corrosion Temp in Green Death Duration is 24 hrs
INCOLOY alloy 25-6MO	60	45
INCOLOY alloy 25-6HN	70	50
INCONEL alloy 625	75	55
INCOLOY alloy 27-7MO	80	65
INCONEL alloy C-276	>boiling	90



**Table 8: ASTM G48-C Pitting Testing**

Base Metal	Filler Metal	Welded Sample CPT (°C)
INCOLOY 25-6MO	INCONEL 686 CPT	55
INCOLOY 25-6MO	INCONEL 625 FM	50
INCOLOY 25-6HN	INCONEL 686 CPT	60
INCOLOY 25-6HN	INCONEL 625 FM	55
INCOLOY 27-7MO	INCONEL 686 CPT	80
INCOLOY 27-7MO	INCONEL 622FM	65

**Table 9: Average Corrosion Rates (mpy) in Acid Solutions at 50°C (122°F)**

Environment	INCOLOY 25-6MO	INCOLOY 25-6HN	INCOLOY 27-7MO
5% HCl	45	55	<0.1
10% H <sub>2</sub> SO <sub>4</sub> +2% HCl	29	<0.1	<0.1
95% H <sub>2</sub> SO <sub>4</sub>	18	20	14.5

## Forming / Fabricating

Hot working of INCOLOY alloy 25-6HN should be performed in the 1800 – 2250°F temperature range. While the alloy has good hot malleability, cracking can occur at lower temperatures. Wrought material can be hot forged or hot pressed into final shapes by conventional methods.

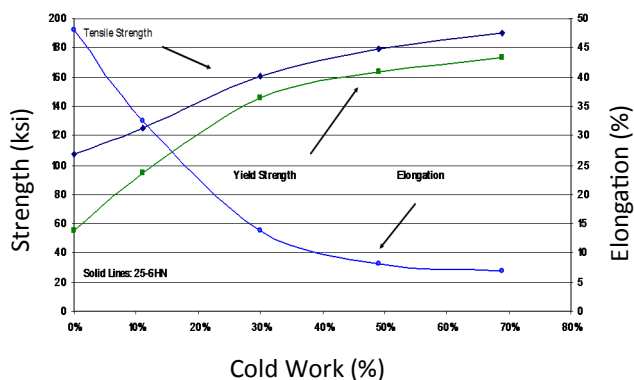
INCOLOY alloy 25-6HN work hardens rapidly (Figure 3). To maintain a clean microstructure, after cold working, alloy 25-6HN products should be solution annealed at a temperature of 2050°F or greater. While heat treating at a lower temperature will recrystallize the deformed structure, it can also induce formation of the embrittling phase, sigma. Components with heavy cross sections should be rapidly cooled by water quenching to avoid sigma phase formation.

Alloy 25-6HN products or components exposed to temperatures between 1100 and 1700°F during service or hot forming can form sigma phase. The presence of sigma reduces the ductility of the alloy product and reduces its resistance to localized corrosion and stress corrosion cracking. As described above, annealing at temperatures of 2050°F or higher will re-solution the sigma phase into the metal matrix and restore properties.

Like other Fe-Ni-Cr-Mo alloys and stainless steels, alloy 25-6HN can suffer catastrophic oxidation if exposed to stagnant conditions at temperatures over 1700°F. Thus, forced gas and air flow is recommended. Stacking of plates or pieces in the furnace should be avoided.

The forming processes used for stainless steels can generally also be used for alloy 25-6HN. Due to its excellent ductility, alloy 25-6HN can be readily formed into complex shapes and contours. However, since it is stronger than most conventional stainless steels, more power is required to deform alloy 25-6HN.

**Figure 3: Cold Working**



**INCOLOY® alloy 25-6HN**

## Machining

Machining characteristics of INCOLOY alloy 25-6HN are similar to those of other austenitic and super-austenitic stainless steels. Alloy 25-6HN should be machined at a slightly lower speed than 316 stainless steel due to its higher strength. Tool wear may be slightly higher than similar operations with grade 316 for the same reason. Suggested feeds and speeds for INCOLOY alloy 25-6HN are listed in Table 10. Detailed machining information is found in the SMC publication, "Machining", which is available on the Special Metals website, [www.specialmetals.com](http://www.specialmetals.com).

**Table 10: Machining Guidelines**

Practice	Alloy	Speed (SFPM)	Depth of Cut (inches)	Feed (in/rev)
High Speed Steel Machining	316	35	0.15	0.018
	25-6HN	25	0.15	0.018
Carbide Machining	316	375	0.15	0.018
	25-6HN	350	0.15	0.018
High Speed Steel Drilling	316	30	---	0.005
	25-6HN	25	---	0.005

## Joining

INCOLOY alloy 25-6HN is readily welded using conventional processes such as gas tungsten-arc welding (GTAW/TIG), gas metal-arc welding (GMAW/MIG), shielded metal-arc welding (SMAW/MMA), submerged arc welding (SAW), and plasma arc welding (PAW). Overmatching composition welding products such as INCONEL® 625 and 622 and INCO-WELD® 686CPT® filler metals and INCONEL 112 and 122 and INCO-WELD 686CPT welding electrodes are recommended for joining alloy 25-6HN.

When autogenously welded (as in production of welded tubing) the corrosion resistance of the resulting weld is reduced from that of the wrought base metal. Post-weld heat treatment (PWHT) has been shown to be effective in improving the corrosion resistance of the weld.

For general welding information, refer to the SMC Publication, "Joining" which is available on the Special Metals website, [www.specialmetals.com](http://www.specialmetals.com).

## Specifications

INCOLOY alloy 25-6HN is covered by a variety of specifications. Some of the common ASTM and ASME specifications are listed in Table 11.

**Table 11: Specifications**

Product form	Common Specifications
Plate, Sheet, Strip	ASTM B 688, A240 / ASME SB 688 SA 240
Rod, Bar, and Wire	ASTM B 691 / ASME SB 691
Forgings	ASTM B 564 / ASME SB 564
Forging Stock, Billet	ASTM B472
Welded Tube	ASTM B 676 / ASME SB 676
Welded Pipe	ASTM B 675, B 804 / ASME SB 675
Forged Flanges / Fittings	ASTM B 462 / ASME SB 462
Fittings	ASTM B 366 / ASME SB 366

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