

## Incoloy A-286 (UNS S66286)



Incoloy A-286 provides outstanding corrosion resistance and high strength properties essential for industrial applications up to 1300oF. It maintains good mechanical strength properties even at the extremely low temperatures to -196oC. Outstanding oxidation and heat resistance. Alloy A286 is employed in jet engines and spacejet parts.

Alloy A-286 is easily age hardenable to achieve good mechanical characteristics. It retains its high strength and resistance to oxidation at the elevated temperature ranges up to 1300oF or 700oC. It is an austenitic alloy in the metallurgical conditions.

### Applications

The excellent potential and formation features of Incoloy A-286 make it purposeful in the variety of applications of aerospace and land based gas turbines that are used on the commercial scale. It is also used in the fastener operations in the automotive engine and diverse components for high levels of heat and pressure, sea water, oil and gas applications.

### Chemical Composition

Nickel (Ni)	24 to 27 %
Iron (Fe)	56.5 %
Chromium (Cr)	13.5 to 16 %
Molybdenum (Mo)	1 to 1.50 %
Titanium (Ti)	1.75 to 2.30 %
Carbon ©	0.08 %
Manganese (Mn)	2 %
Silicon (Si)	1 %
Vanadium (V)	0.10 to 0.50 %
Aluminium (Al)	0.35 %

Boron (B)

0.003 to 0.010 %

## Physical Properties

Density	7.94 g/cm <sup>3</sup> or 0.287 lb/inch <sup>3</sup>
Melting Point	1430oC or 2600oF
Modulus of Rigidity	71.5 kN/mm <sup>2</sup> or 10370 ksi
Modulus of elasticity	205 kN/mm <sup>2</sup> or 29773 ksi
Highest application temperature	816oC or 1500oF
	982oC or 1800oF
Melting Point	1370oC to 1430oC or 2500oF to 2610oF
Solidus point	1370oC or 2500oF
Liquidus point	1430oC or 2610oF
Thermal conductivity	15.1 W/m-K at temperature 150oC or 105 BTU-in/hr-ft <sup>2</sup> -°F at 302oF
Specific heat capacity	0.420 j/g-oC or 0.100 BTU/lb-oF
Linear coefficient of thermal expansion	16.5 micro-m/moC at 20 to 93oC or 9.17 micro-inch/inch-oF from 68 to 199oF
	17 micro-m/moC from 20 to 315oC or 94 micro-inch/inch-oF from 68oF to 599oF
	17.6 micro-m/moC at 20oC to 538oC or 9.78 micro-inch/inch-oF from 68 to 1000oF
Magnetic permeability	1.01
Electrical Resistivity	0.0000910 ohm-cm
Hardness, Rockwell B	85
Tensile Strength, Ultimate	620 Mpa or 89900 psi
Yield strength	275 Mpa or 39900 psi
Elongation %	40 %
Modulus of elasticity	201 GPa or 29200 ksi
Poisson ratio	0.30
Shear Modulus	77 GPa or 11200 ksi

## Modulus of Elasticity

Temperature		X 10(6) psi	X 10(3) MPa
oF	oC		
70 oF	21.1 oC	28.8 X 10(6) psi	199 X 10(3) MPa
1000 oF	538 oC	23.7 X 10(6) psi	163 X 10(3) MPa
1100 oF	593 oC	22.8 X 10(6) psi	157 X 10(3) MPa
1200 oF	649 oC	21.9 X 10(6) psi	151 X 10(3) MPa
1300 oF	704 oC	21.1 X 10(6) psi	145 X 10(3) MPa
1400 oF	760 oC	20.1 X 10(6) psi	139 X 10(3) MPa
1500 oF	816 oC	18.7 X 10(6) psi	129 X 10(3) MPa

## Mean Coefficient of thermal expansion

Temperature		Per oF	Per oC
200 oF	93 oC	9.17 x 10(-6) per oF	16.5 x 10(-6) per oC
400 oF	204 oC	9.35 x 10(-6) per oF	16.8 x 10(-6) per oC
600 oF	316 oC	9.47 x 10(-6) per oF	17 x 10(-6) per oC
800 oF	427 oC	9.64 x 10(-6) per oF	17.4 x 10(-6) per oC
1000 oF	538 oC	9.78 x 10(-6) per oF	17.6 x 10(-6) per oC
1200 oF	649 oC	9.88 x 10(-6) per oF	17.8 x 10(-6) per oC
1300 oF	704 oC	9.94 x 10(-6) per oF	17.9 x 10(-6) per oC

1400 oF	760 oC	10.32 x 10(-6) per oF	18.6 x 10(-6) per oC
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## Mechanical Properties

Temperature		.02 % Yield strength		0.2 % Yield strength		Tensile strength		Elongati on %	Reduction area %
oF	oC	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa		
70 oF	21.1 oC	90 Ksi	621 Mpa	95 Ksi	655 Mpa	145 Ksi	1000 Mpa	24 %	45 %
400 oF	204 oC	76 Ksi	524 Mpa	93.5 Ksi	645 Mpa	143 Ksi	986 Mpa	21.5 %	52 %
800 oF	427 oC	72 Ksi	496 Mpa	93 Ksi	641 Mpa	138 Ksi	951 Mpa	18.5 %	35 %
1000 oF	538 oC	62 Ksi	427 Mpa	87.5 Ksi	603 Mpa	131 Ksi	903	18.5 %	31 %
1100 oF	593 oC	64.5 Ksi	445 Mpa	90 Ksi	621 Mpa	122 Ksi	841 Mpa	21 %	23 %
1200 oF	649 oC	62.5 Ksi	431 Mpa	88 Ksi	607 Mpa	103.5 Ksi	714 Mpa	13 %	14.5 %
1300 oF	704 oC	68.5 Ksi	472 Mpa	86 Ksi	593 Mpa	86.5 Ksi	596 Mpa	11 %	10 %
1400 oF	760 oC	44.5 Ksi	307 Mpa	62 Ksi	427 Mpa	64 Ksi	441 Mpa	18.5 %	23 %
1500 oF	816 oC	31 Ksi	214 Mpa	33 Ksi	228 Mpa	36.5 Ksi	252 Mpa	68.5 %	37.5 %

### Stress rupture properties

Temperature		Stress required for rupture					
oF	oC	100 hours		% elongation in 3D	1000 hours		% elongation in 4D
		Ksi	Mpa		Ksi	Mpa	
1000 oF	538 oC	99 Ksi	683 Mpa	3 %	88 Ksi	607 Mpa	3 %
1100 oF	593 oC	81.5 Ksi	562 Mpa	3 %	71.5 Ksi	493 Mpa	3 %
1200 oF	639 oC	61 Ksi	421 Mpa	5 %	46 Ksi	317 Mpa	8.5 %
1300 oF	704 oC	44.5 Ksi	307 Mpa	12 %	29 Ksi	200 Mpa	30 %
1350 oF	732 oC	35 Ksi	41 Mpa	29 %	21 Ksi	145 Mpa	35 %
1500 oF	816 oC	13 Ksi	90 Mpa	55 %	7.7 Ksi	53 Mpa	-

## Corrosion Resistance

The resistance to corrosion offered by Incoloy A-286 alloy is due to the concentration of nickel and chromium. It is superiorly resistant to oxidation and corrosion. The alloy offers excellent resistance to oxidation at the operation temperatures of 1300oF or 700oC.

## Fabrication

Incoloy A-286 is easily fabricated by following the regular processes that are used for stainless steel and nickel alloy formation. The cold processing is performed on the specimen in the solution processed condition. The processes, forces and work toughening rates are equivalent to the Inconel 600 and Incoloy 800.

For hot formation, alloy A-286 is heated at 2100oF or 1150oC. The ultimate reductions at temperature of 1800oF or 980oC must be more than 10% to restrict the large grain formation in the solution processing. The formation process is not performed at temperatures lower than 1700oF or 930oC. The heat processing of Incoloy A-286 alloy is done at 1800oF or 980oC or 1650oF or 900oC, followed by the frequent cooling by age hardening for continuous 16 hours at temperature of 1325oF or 720oC and then air quenching is performed.

The solution processing at 1800oF offers maximum creeping resistance in the age toughened alloy A-286 although work processing at 1650oF offers enhanced ductility and room temperature tensile properties.

### **Available Forms**

Wire, mesh, strip, pipe, tubing, bar, rod, flanges, sheet, plate, foil