Austral Wright Metals
at the cutting edge

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PRODUCT DATA SHEET

Titanium Grade 12

UNS R53400

Titanium Alloys

Titanium Grade 12 has outstanding corrosion resistance and a combination of high strength and low density, with good ductility. Small additions of nickel and molybdenum have been made to this alloy resulting increase in corrosion resistance and high strength. It is particularly suitable for use in mildly reducing conditions, or where conditions vary from oxidising to reducing. It is particularly resistant to crevice corrosion in hot brines.

Chemical Composition

(ASTM B265 – Titanium & titanium alloy strip, sheet & plate)

Element	%	Element	%
Titanium	Balance	**Iron**	0.30 max
Nitrogen	0.03 max	**Oxygen**	0.25 max
Carbon	0.08 max	**Molybdenum**	0.2 – 0.4
Hydrogen	0.015 max	**Nickel**	0.6 – 0.9
Residuals, each	0.1	**Residuals, total**	0.4

Specified Minimum Mechanical Properties

(ASTM B265 – Titanium & titanium alloy strip, sheet & plate)

	Annealed
0.2% Proof Stress, MPa	345
Tensile Strength, MPa	483
Elongation, %	18

Typical Applications Many of the applications of grade 12 titanium are in the chemical industries. The common uses in Australia are in chemical processing, where titanium grade 12 is used for reactor autoclaves, piping and fittings, valves, heat exchanges and condensers.

Description Titanium Grade 12 is a highly corrosion resistant alloy containing small additions of nickel and molybdenum, which enhance corrosion resistance and increase the strength of the alloy to give better mechanical properties than the commercially pure grades. It is used in mildly reducing or fluctuating conditions. In particular, it is used instead of the commercial purity grades (e.g.grade 2) for better resistance to crevice corrosion in hot brines, and where the extra strength allows the use of lighter sections.

At room temperature it is an alpha alloy, and may contain minor amounts of beta phase. It transforms to beta phase at $890^{o}C \pm 15^{o}C$

Titanium is reactive, and has a very high affinity for oxygen, which forms a skin of very stable and highly adherent oxide. The skin gives excellent corrosion resistance, despite the reactivity of the metal. The oxide layer forms spontaneously and on exposure to the atmosphere. However, when new parent metal is exposed to anhydrous conditions or in the absence of air, rapid corrosion may occur. Care should also be taken if titanium is to operate in contact with hydrogen, as hydrogen embrittlement from hydride formation can increase strength, with loss of ductility.

Austral Wright Metals can supply titanium 12 as plate, sheet and strip, rod and bar, seamless and welded pipe, weld fittings, seamless and welded tube, forging billet and forgings.

Pressure Vessels AS1210 & ASME Boiler & Pressure Vessel Code pre-qualify Titanium 12 for use in pressure vessels up to $300^{o}C$.

Corrosion Resistance Titanium alloys are usually used in Australia for their excellent corrosion resistance, especially to chloride solutions. The small additions of nickel and molybdenum to grade 12 titanium give a more corrosion resistant metal than the commercial purity grade 2 alloy, with a marked increase in strength. The overall corrosion resistance of this grade is not as good as the

palladium alloyed lean grade 7, except for resistance to crevice corrosion in hot chloride solutions. Titanium has excellent resistance to general corrosion, with loss rates of less than 0.04mm/year being typical. The Austral Wright Metals Product Data Sheet "Corrosion of Titanium and Titanium Alloys" or your local office should be consulted more details.

Environment	Typical Corrosion Rate mm/year	Environment	Typical Corrosion Rate mm/year	Environment	Typical Corrosion Rate mm/year
Wet Cl_2 gas	0.000 89	50% citric acid	0.013	88 – 90% formic acid	0 – 0.56
5% NaOCl + 2% NaCl + 4% NaOH †	0.06	10% sulphamic acid	11.6	90% formic acid ‡	0.56
70% zinc chloride	0.005 – 0.007 5	45% formic acid	Nil	10% oxalic acid	104

† no crevice corrosion in metal-to-metal or metal-to-Teflon crevices ‡ anodised specimens
Source: Metals Handbook, vol 2, ASM

Fabrication Titanium Grade 12 is forged conventionally, within the narrow temperature range 815 - 900°C. Titanium and its alloys are generally more difficult to forge than both aluminium and alloy steels, due to their high strain rate sensitivity and rapid increase of strength with falling temperature. Hot forging leaves a thick, hard outer layer of titanium oxide on the surface. This layer is called "Alpha Case" and is usually removed by pickling in a mixture of nitric and hydrofluoric acids. As supplied, titanium alloys are usually annealed and pickled, and can be readily cold formed in conventional machines using standard methods. In cold forming the "alpha case" does not form and further pickling is not needed, except to remove any carbon steel embedded in the surface, which can cause pitting corrosion.

Machinability Titanium Grade 12 is readily machinable by conventional methods. Like stainless steel, titanium has a low thermal conductivity and heat dissipation is inhibited, so copious amounts of coolant should be used. Sharp carbide tools are used. Deep, continuous cuts are best.

Welding Titanium Grade 12 is readily weldable by GMAW (MIG) and GTAW (TIG) processes. Preheat or post weld heat treatment are not needed. The area to be welded must be **CLEAN**, free from all grease and shop dirt, including marking pencil marks. A trailing gas shield is used in addition to the normal welding torch gas shield, to prevent heavy oxidation during cooling. Matching filler metal to AWS specification ERTi-12 is used. The gas shield must be low in hydrogen, oxygen and nitrogen, all of which readily dissolve in titanium and cause embrittlement.

Heat Treatment Titanium Grade 12 is normally supplied in the annealed condition. After fabrication, stress relief at 480 – 595°C, air cooled, may be required to improve dimensional stability.

Physical Properties

Property	At	value	unit	Property	at	Value	unit
Density	20°C	4,507	kg/m³	Specific Heat	20°C	519	J/kg . °C
Melting Range		1668 ± 10	°C	Mean Coefficient of Expansion	20°C	8.41	x 10^{-6} / °C
Modulus of Elasticity Tension	20°C	103	GPa	Thermal Conductivity	20°C	11.4	W / m . °C
				Electrical Resistivity	20°C	0.420	micro-ohm . m

ASTM Product Specifications

Specification	Title
B265	Titanium and Titanium Alloy Strip, Sheet and Plate
B381	Titanium and Titanium Alloy Forgings
B348	Titanium and Titanium Alloy Bars and Billets
B337	Seamless and Welded Titanium and Titanium Alloy Pipe
B338	Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers