Grade 2 Unalloyed Ti ("Pure") 50A (UNS R50400)

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Topics Covered

Introduction

Commercially pure titanium alloys contain small amounts of oxygen and iron that influence mechanical properties. Each commercial grade is produced to provide properties suited for different applications.

Grade 2 Unalloyed Ti ("Pure") 50A alloy is the most commonly used and widely available grade of unalloyed titanium. It is non-magnetic. This alloy has been approved for sour service use under the NACE MR-01-75 Standard.

The following sections will discuss in detail about grade 2 Unalloyed Ti ("Pure") 50A alloy.

Chemical Composition

The chemical composition of grade 2 Unalloyed Ti ("Pure") 50A alloy is outlined in the

following table.

Element	Content (%)
Titanium, Ti	≥ 98.9
Iron, Fe	≤ 0.30
Oxygen, O	≤ 0.25
Carbon, C	≤ 0.080
Nitrogen, N	≤ 0.030
Hydrogen, H	≤ 0.015

Physical Properties

The physical properties of grade 2 Unalloyed Ti ("Pure") 50A alloy are tabulated below.

Properties	Metric	Imperial
Density	4.51 g/cm^3	0.163 lb/in^3
Melting point	1660°C	3020°F

Mechanical Properties

The following table shows mechanical properties of grade 2 Unalloyed Ti ("Pure") 50A alloy.

Properties	Metric	Imperial
Tensile strength	485 MPa	70300 psi
Yield strength	345 MPa	50000 psi
Poisson's ratio	0.34-0.40	0.34-0.40
Elastic modulus	105 - 120 GPa	15200 - 17400 ksi
Elongation at break	28%	28%
Hardness (HV)	160-200	160-200

Thermal Properties

The thermal properties of grade 2 Unalloyed Ti ("Pure") 50A are tabulated below.

Properties	Metric	Imperial
Thermal expansion co-efficient (@0.000-100°C/32-212°F)	8.60 µm/m°C	4.78 µin/in°F
Thermal conductivity	21.97 W/mK	152.5 BTU in/hr.ft².°F

Other Designations

Equivalent materials to grade 2 Unalloyed Ti ("Pure") 50A alloy are as follows:

ASTM B265	ASTM B337	ASTM B381	ASTM F67
AMS 4941	ASTM B338	ASTM B348 (2)	ASTM F468 (2)
AMS 4902	AMS 4942	ASTM B348	ASTM F467 (Ti-2)
MIL T-9047	ASTM F67 (2)	DIN 3.7035	MIL T-9046

Fabrication and Heat Treatment

Machinability

Grade 2 Unalloyed Ti ("Pure") 50A alloy is hard to machine but can be successfully done using slow speeds, high coolant flow, and high feed rates. Tooling should be performed using tungsten carbide designations C1-C4 or cobalt type high speed tools.

Forming

Grade 2 Unalloyed Ti ("Pure") 50A alloy can be hot or cold formed using power brake, hydropress, stretch or drop hammer methods.

Welding

Weldability of grade 2 Unalloyed Ti ("Pure") 50A alloy is rated as good.

Annealing

Annealing of this material can be performed by heating to 704°C (1299°F), and then held for 2 h, which should be followed by air cooling. In case intermediate stress relieving is required, the material has to be heated to 482°C (900°F) for 45 min.

Forging

Rough forging can be performed at 899°C (1650°F) and completed at 843°C (1550 °F).

Hot Working

Hot working enhances the overall ductility of the material.

Cold Working

Cold working features of this material is same as that of a moderately tempered austenitic stainless steel. Post-work annealing is recommended to re-attain favorable performance properties.

Applications

Grade 2 Unalloyed Ti ("Pure") 50A alloy is used in the following application areas:

- Navy ship parts
- Food processing/pharmaceutical
- Chemical processing equipment
- Anode/cathode/cell parts
- Aircraft ducting, hydraulic, and tubing
- Air pollution control equipment
- Hydrocarbon refining/processing
- Pulp/paper bleaching/washing equipment
- Power plant cooling system components
- Desalination, brine concentration/evaporation
- Hydrometallurgical extraction/electrowinning
- Medical implants/devices, surgical instruments
- Consumer products
- Sports/recreational equipment
- Offshore hydrocarbon production/drilling