Titanium Alloy Data Sheet

Description

Titanium equipment is often used in severe corrosive environments encountered in the chemical processing industries. Titanium has been considered an exotic "wonder metal" by many. This was particularly true in reference to castings. However, increasing demands and rapidly advancing technology have permitted titanium castings to be commercially available at an economical cost. The combination of its cost, strength, corrosion resistance, and service life in very demanding corrosive environments suggest its selection in applications where titanium castings have never been considered in the past.

Specifications

Flowserve's commercially pure titanium (C.P.-Ti) castings conform to ASTM Specification B367, Grade C-3. Flowserve's palladium stabilized titanium (Ti-Pd) castings conform to Grade Ti-Pd 8A.

Composition

	C.P.-Ti (C-3)	**Ti-Pd (8A)**
Element	Percent	Percent
Nitrogen	0.05 max.	0.05 max.
Carbon	0.10 max.	0.10 max.
Hydrogen	0.015 max.	0.015 max.
Iron	0.25 max.	0.25 max.
Oxygen	0.40 max.	0.40 max.
Titanium	Remainder	Remainder
Palladium	—	0.12 min.

Minimum Mechanical and Physical Properties

	C.P.-Ti (C-3) & Ti-Pd (8A)
Tensile Strength, psi	65,000
MPa	448
Yield Strength, psi	55,000
MPa	379
Elongation, % in 1" (25 mm), min.	12
Brinell Hardness, 3000 kg, max.	235
Modulus of Elasticity, psi	15.5×10^6
MPa	107,000
Coefficient of Expansion,	
in/in/°F@ 68-800°F	5.5×10^{-6}
m/m/°C @ 20-427°C	9.9×10^{-6}
Thermal Conductivity,	
Btu/hr/ft/ft²/°F @ 400°	9.8
WATTS/METER-KELVIN @ 204°C	17
Density lb/cu in	0.136
kg/m³	3760
Melting Point, °F (approx.)	3035
°C	1668

Corrosion Resistance

The outstanding mechanical and physical properties of titanium, combined with its unexpected corrosion resistance in many environments, makes it an excellent choice for particularly aggressive environments like wet chlorine, chlorine dioxide, sodium and calcium hypochlorite, chlorinated brines, chloride salt solutions, nitric acid, chromic acid, and hydrobromic acid. It also has exceptional resistance to most chlorinated hydrocarbons and organic acids except oxalic and formic acids. The corrosion rate of titanium in formic acid may be reduced significantly by the addition of an oxidizing salt such as ferric or cupric chloride.

Palladium stabilized titanium possesses all the corrosion resistance of C.P.-Ti and is essentially immune to pitting or crevice corrosion. Figures 1 and 2 contain graphs of temperature versus pH relationship of C.P.-Ti and Ti-Pd in saturated sodium chloride brines. Even in neutral brines corrosion can occur in crevices of C.P.-Ti above 235°F. Lowering the pH to 1 in a similar brine will not cause crevice corrosion in Ti-Pd until temperatures of 400°F are exceeded. The 0.12 percent min. palladium present in Ti-Pd also greatly improves resistance to such reducing acids as hydrochloric and dilute sulfuric.

Heat Treatment

None required or recommended.

Weldability

Anyone capable of welding stainless steels can weld titanium as long as certain precautions are observed. These include: an inert gas welding process; protection from the atmosphere; and non-coated electrodes. Titanium, being a reactive metal, has an extremely high affinity for oxygen and nitrogen (it acts as a blotter for these elements) and absorption of even small quantities of these elements will embrittle a weld severely. Though titanium is easily welded, the “secret” of welding is cleanliness and ingenuity exercised in protecting the weldment from the atmosphere. A guide to indicate the acceptability of a titanium weldment is its color. A silvery appearance is indicative of a well protected, ductile weldment; a straw or light yellow through light blue color signals a slight amount of contamination, but normally an insufficient quantity to be damaging; and a dark blue through purple or the formation of a white powdery substance indicates contamination to the extent of serious embrittlement.

Machineability

Titanium castings can be machined as readily as stainless steels by following well established practices and procedures. Titanium is less prone to work hardening than austenitic stainless steels but has low heat conductivity, resulting in higher temperatures on the cutting edge of the tool. Consequently, tool life is relatively short. Basic knowledge and understanding of machining procedures combined with a little practice will provide satisfactory results. Care must be taken to minimize very fine chips since they are pyrophoric (i.e., may spontaneously ignite in the presence of air).

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