Titanium Parts Need Titanium Brushes

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The Problem

The use of stainless steel brushes on titanium parts has been a common practice since titanium came into widespread industrial use. When a titanium part is brushed with a stainless steel brush, small amounts of the stainless steel are abraded from the brush fiber and embedded in the surface of the titanium. The two dissimilar metals are physically bound. When moisture is added, the result is the creation of a battery and the start of galvanic corrosion.

Galvanic corrosion (also called dissimilar metal corrosion) refers to corrosion damage induced when two dissimilar materials are coupled in a corrosive environment. When a galvanic couple forms, the least noble of the metals in the couple becomes the anode [the stainless steel] and corrodes faster than it would all by itself, while the other becomes the cathode [the titanium part] and corrodes slower than it would alone. “A small anodic area relative to the cathodic area should be avoided” [MIL-STD-8898 5.1.4].

The extent of the corrosion is determined by the efficiency of the battery. Like most batteries, the potential is expressed in volts. The amount of potential voltage in the couple is expressed in the Anodic Index and is determined by the difference in the voltage potentials between the two metals. Titanium has a relative potential of .30v. The 400 series stainless steels have a potential of .60v. The difference in their potentials is .30v. If a 300 series stainless brush was used, the difference is .20v.

Using a pacified stainless steel, which is much closer to titanium in the Anodic Index, is an acceptable solution when joining fixed parts but, a brush, unlike a washer, is constantly being abraded against the work piece. With a pacification layer measured in angstroms [~ 3 angstroms] it is evident that protective oxide would be readily removed and the part of the brush in contact with the work piece would no longer be pacified.

Recommendation

How much corrosion is acceptable? That would, of course, depend on where it appeared: In your artificial heart valve? In the actuator arm of a space probe? In the rudder control assembly of a 747? The solution to the problem is to use titanium brushes on titanium parts. No dissimilar metals = no battery = no corrosion.

Anodic Index V	Titanium 0.30 18% chromium type corrosion-resistant steels [302, 304, 316] 0.50 12% chromium type corrosion-resistant steels [410, 416, 420] 0.60

Normal Environment	In normal environments, such as storage in warehouses or non-temperature and humidity controlled environments there should not be more than 0.25 V difference. A 300 series brush is marginally acceptable but, a titanium brush is preferred.
Controlled Environment	In controlled environments that are temperature and humidity controlled, 0.50V can be tolerated. A titanium brush is not required
Harsh Environment	In harsh environments, such as outdoors, high humidity, and salt environments there should be not more than 0.15 V difference in the "Anodic Index.” The only acceptable wire brush would contain 100% titanium

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1 row - 11TID
2 row - 22TID
3 row - 33TID

Hand tied aluminum handle
.008 Titanium fill

1 row - 11TIA
2 row - 22TIA
3 row - 33TIA

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