Racking Concepts for Aluminum Anodizing

SANFORD PROCESS™
THE WORLD'S FINEST HARD ANODIZE PROCESS

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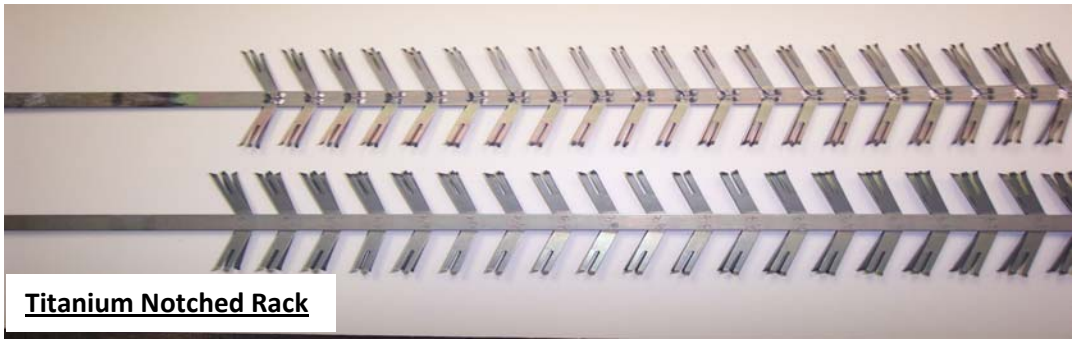
Resistance

- **A conductor allows an electric current to flow through it, but it does not permit the current to flow with perfect freedom. Collisions between the electrons and the atoms of the conductor interfere with the flow of electrons. This phenomenon is known as resistance. Resistance is measured in units called ohms. The symbol for ohms is the Greek letter omega, Ω. *A good conductor is one that has low resistance.***
- **At commonly encountered temperatures, silver is the best conductor and copper is the second best. Electric wires and bus bars are usually made of copper or aluminum, which is less expensive than silver.**

Resistance of Anodizing Racks

A thicker wire, however, has less resistance, because a thick wire offers more room for an electric current to pass through than a thin wire does. A wire whose cross-sectional area is twice that of another wire of equal length and similar material has only half the resistance of the thinner wire. *The resistance is proportional to length and inversely proportional to crcross-sectional area.*

The racks used in hard anodizing serve two very important functions. First they provide a convenient way to transfer the work from tank to tank and secondly they form a vital link in the electrical circuit by providing a positive means of supplying the required current to the parts.

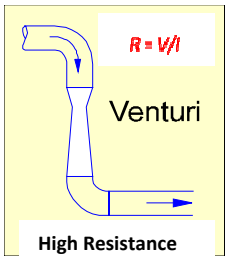


Titanium Notched Rack



Aluminum racks

Usually, the higher  **the temperature of a wire (rack), the greater its resistance.**  **The resistance of some materials drops to zero at very low temperatures. This phenomenon is known as superconductivity. In our case (Hard Anodizing Process), aluminum or titanium racks at 28-32ºF temperature**  **of electrolyte become less resistance to the current...**  **The resistance of a piece of wire (aluminum or titanium racks) depends on its length, and its cross-sectional area, or thickness. *The longer the wire is, the greater its resistance.* If one wire is twice as long as a wire of identical diameter and material, the longer wire offers twice as much resistance as the shorter one.**



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Heat and Power

- **A conductors (racks, contact points and electrolyte) resistance to electric current produces heat. The greater the current passing through the conductor, the greater the heat. Also, the greater the resistance, the greater the heat. A current of *I* amp passing through a resistance of *R* ohms for *t* seconds generates an amount of heat equal to I^2Rt joules (a joule is a unit of energy equal to 0.239 calorie).**
- **V (voltage) x I (current) = W (watts)**



CURRENT-CARRYING CAPACITY OF SPECIFIC SIZES OF RACK MEMBERS

Aluminum Rectangular & Square Bar

Size		Cross-sectional Area		Amperes
in	cm	in²	cm²	Capacity
1/2 x 1/2	1.3 x 1.3	0.25	1.69	220
1/4 x 1/4	0.6 x 1.3	0.125	0.78	110
1/4 x 3/4	0.3 x 1.9	0.1875	0.57	175
5/16 x 3/4	0.8 x 1.9	0.234	1.52	210
3/4 x 3/4	1.9 x 1.9	0.5625	3.61	480
1 x 1	2.5 x 2.5	1.0	6.25	850
1 x 2	2.5 x 5.1	2.0	12.75	1700

Aluminum Rod

Size		Cross-sectional Area		Amperes
in	cm	In²	cm²	Capacity
1/8	0.3	0.0123	0.071	12
3/16	0.5	0.0276	0.196	24
1/4	0.6	0.0491	0.283	38
5/16	0.8	0.0767	0.503	65
3/8	1.0	0.1104	0.785	93

Titanium Rectangular & Square Bar

Size		Cross-sectional Area		Amperes
in	cm	in²	cm²	Capacity
1/8 x 3/4	0.3 x 1.9	0.0947	0.57	35
1/2 x .050	1.3 x 0.1	0.025	0.13	8
1/4 x 3/4 Double Splines	0.6 x 1.9	0.1875	1.41	70
1/2 x 3/4	1.3 x 1.9	0.375	2.47	140

Titanium Rod

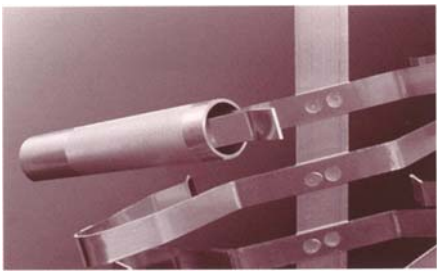
Size		Cross-sectional Area		Amperes
in	cm	in²	cm²	Capacity
1/16	0.2	0.0031	0.031	1.1
3/32	0.2	0.0070	0.031	2.5
1/8	0.3	0.0123	0.071	4.5
3/16	0.5	0.0276	0.196	10
1/4	0.6	0.0491	0.283	16

NOTE: The above values are conservative, in that they specify amount of current given cross-section will carry without heating. In actual practice, slightly more current can safely be carried, since a minor amount of warming of the conductor can be allowed. In hardcoating, the cold temperature of the electrolyte enables still higher current, since the bath itself is constantly cooling the submerged portions of the racks.

Typically only Aluminum and Titanium are used for racks. There is a good deal of individual preference in racking. However, certain general rules should be observed.

Location

Racking points should be selected so that part function and/or appearance are not affected. Distance between contact points should not be over 1,000 times part thickness in inches.



Position

Parts should be positioned to allow the solution to flow over exposed areas. For instance, parts with internal bores should be placed vertically in the tank. If it is a blind bore, the part should be positioned with the open end up.

Contact

There should be firm mechanical contact to avoid movement during processing.
Electrical contact should be sufficient to provide adequate current flow-
30 amps/sq.in. for hard anodizing (Type III)!
For conventional anodizing (Type III)15 amps/sq.in. will be plenty.

Cross-sectional area

Amperage carrying capacity is a direct function of the cross-sectional area and material of the conducting member.

Cleaning

Racks should be kept clean and acid free. Rinse down all racks, clips, bars, etc., before removal from the rinse tank. This is essential. Keep bus bars and anode bars clean at all times.

Determining Minimum Rack Size (contact points) for Customer Part



Minimum Rack Size is determined by:

– surface area of the part

– aluminum alloy (some aluminum alloys should be run with alumin only!)

For example, if the surface area of the one part is 1 sq. ft. the minimum current density should be 30 ASF then for 10 pcs. maximum current will be 30 amps/sq. ft. X 10 pcs. = 300A

For aluminum rod racks the total cross section for one part should be around ¼”. For titanium rod racks the total cross section for one part should be around 1/2”. The cross-section numbers are representing size of the mark (non-anodized indication) on the surface area of customer part. (See current carry capacity tables above).