Air agitation requirements in a Type III anodizing tank

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Design of an air agitation system for hard anodizing includes selection of type of air equipment to use, determination of required output air capacity, sparger design and location.

Equipment selection

Hard anodizing requires large amounts of air agitation which can be inexpensively provided by a regenerative blower system. Air compressors are generally not recommended for air agitation in a hard anodizing tank as they are designed to provide relatively small amounts of high pressure air. In addition, regenerative blowers do not require moisture or oil removal equipment normally found in compressor systems. This makes the regenerative blower very economical to obtain and operate.

Blower sizing

The regenerative blower size is specified in terms of its output capacity in standard cubic feet per minute and the back pressure against which it pumps. The back pressure may be expressed in gauge pressure (PSIG) or inches of water.

A rule of thumb for estimating the required output capacity of a blower for hard anodizing is that the air supply must provide 2 scfm for each linear foot of air line in the tank[1]. Thus for a ten foot long tank with three air spargers running the length of the tank, the air supply must provide 2*10*3 = 60 scfm of air.

A more rigorous sizing method is based on the surface area of the tank.[2] The required flow rate is equal to the total surface area of the tank multiplied by an 'agitation factor'. Conversations with the Ametek Rotron company indicate that the agitation factor for Type III anodizing is 2.0. Thus for an anodizing tank that is ten feet long and four feet wide, the air requirement is 10*4*2.0 = 80 scfm.

The air supply pressure required is:

P (in PSIG) = 0.43TD+0.75

where T is the solution depth in feet, and D is the specific gravity of the solution.

The pressure drop due to frictional losses in the piping is estimated at 0.75 psig. This estimate assumes a run of 20 feet or less from blower to tank.

[1] Ted Mooney, in Metal Finishing Guidebook and Directory Issue, Vol. 94, 1996 p. 684

[2] Improving Electroplating Quality and Productivity Using Regenerative Blowers, Ametek Rotron, copyright 1998.

For a 4 foot deep tank operating at the specifications (190 g/L H_2SO_4, 9 g/L additive, 4- 12 g/L Al, D = 1.160 g/ml) the required pressure is 2.75 PSIG. Most regenerative blowers are capable of providing upwards of 3 psig. In the case of a blower being marginally suited for an application, an exact analysis of the pressure drop in the system should be performed.

Adjustments for Type II anodizing and for Rinse Tanks

For a Type II system, the agitation factor is 1.5. A Type II tank that has open surface dimensions of 4’x10’ would require 60 SCFM of air. The rest of the design is unchanged.

Similarly, rinse tanks require an agitation factor of 1.0.

Blower connection and general layout

The blower should be plumbed as per the manufacturers recommendations. A relief valve must be installed in line to prevent overpressurization of the blower and subsequent damage. A gate valve is also recommended so that the blower can be vented when the air to the tank is turned off but the blower is left running. If the blower is left running, pressure builds until the relief valve opens and the air is bled off. However, the relief valve is very restrictive and the blower draws more current than normal, resulting in overheating and possible failure. Table 1 provides recommended pipe diameters for various air flow rates. Referring to Table 1, an 80 scfm blower should be plumbed with 2” i.d. pipe or larger.

Table 1. Recommended air flow for various pipe diameters*

Pipe Inner Diameter	SCFM	Pipe Inner Diameter	SCFM
0.5”	2-5	2.5”	130-260
0.75”	6-13	3”	200-400
1.0”	12-25	4”	400-800
1.25”	21-45	5”	800-1300
1.5”	35-70	6”	1100-2200
2.0”	70-140	8”	2100-4200

* From *Improving Electroplating Quality and Productivity Using Regenerative Blowers, Ametek Rotron*

General layout

The air from the blower is brought to the tank in a single line (2” for the example used here). At the tank, the line should be divided so that air is supplied to both ends of the tank. For ease of assembly, this can be the same size as the single supply line if desired. The lines are brought to both ends of the tank where the spargers are attached.

Sparger design

A typical sparger will produce a 6 to 9 inch zone of effective agitation. It is recommended that spargers be located so that the racks of parts are completely within the well agitated area. This will probably necessitate 3 or 4 air lines placed approximately 9 inches apart, centered under the racks. Some experimentation will be necessary to determine the exact number and location of the air lines.

It is recommended that the air lines are manifolded and supplied from both ends of the tank, thus avoiding excessive pressure drop and ensuring balanced air delivery. In addition, the installation of control valves on each air sparger should be considered so that the air supply in the tank can be balanced for uniform agitation. Figures 1 and 2 show schematic drawings of air sparger systems employing valving on both ends (Figure 1) to allow end to end air balance in the tank and valving on each air line (Figure 2) for complete control of air agitation in the tank.

Figure1. Air sparger system with valves allowing control of air flow from end to end.

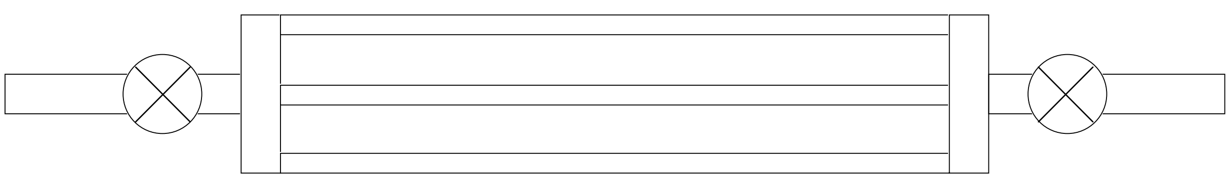
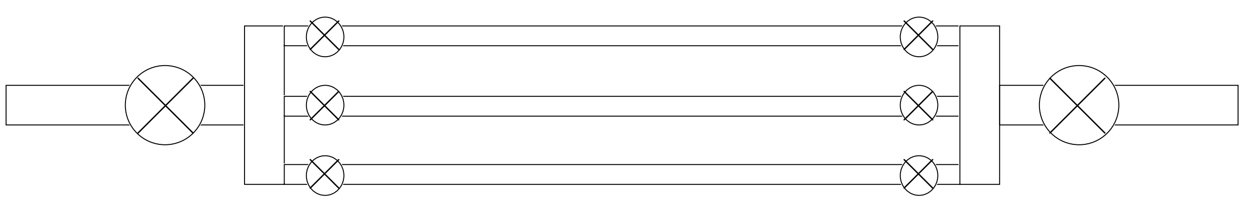
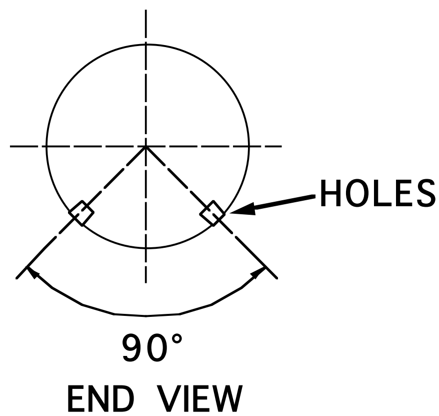


Figure2. Air sparger system with valves allowing control of air flow from end to end and air line to air line.



The drilled air holes should be 3/32" diameter for best bubble size. The total surface area of the holes should not exceed the cross sectional surface area of the supply piping. For example if 1 inch i.d. piping is used, and the drilled holes are 3/32" in diameter (0.00690 in^2 surface area), approximately 114 holes may be drilled in each pipe. Or, if 1.25" i.d. pipe is used (1.227 in^2 area), 177 holes may be drilled in each pipe. The holes in the sparger should be facing down on two rows, 90° apart, and staggered on alternating sides along the length of the pipe, as shown in Figure 3.

Figure 3. Hole layout in cross section showing holes staggered along length of pipe.



For maximum flexibility it may be beneficial to manifold the spargers together using pipe nipples so that the spargers can be easily moved or replaced in the future.

The spargers and valves may be constructed of materials that are not subject to attack by 10% acid solutions. This includes Schedule 40 PVC, Schedule 80 PVC, polypropylene, etc. The use of nylon is not recommended in the tank.

For a 3 line system that is supplied with 80 scfm, each line will have 26.7 scfm flowing through it and so the pipe diameter should be1.25".For a 4 sparger system, each sparger will carry 20 scfm, so 1" pipe will be sufficient.

Summary

Tank Dimensions: 10’x4’x4’

Solution : CHEMEON Anodizing Electrolyte

Required Blower: 80 scfm at 2.78 psig, pressure relief and gate valves installed.

Plumbing to tank: 2” i.d. pipe (PVC, etc.)

Spargers: 4 ea. 1” i.d. with up to 114 holes 3/32” dia. facing down, staggered as described above.