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Air Agitation Sparging Systems for Electroplating Applications

The preferred air supply (blower) for air agitation of electroplating solutions is of the "Roots" high volume, low-pressure type. The blower selected should be installed with the necessary in-line oil and water separation traps to ensure an oil free air supply. The blower should be sized to meet the required air delivery volume (CFM) at the required air pressure (PSI). Even the most efficient blowers tend to heat the ambient air supply and consequently provide a positive heat load to the process tank. In order to prevent supplemental heat input to the plating tank the air supply intake should preferably be located in a cool dust free interior location.

Uniform distribution of the air supply throughout the tank is critical to providing uniform solution agitation that promotes uniform leveling and brightness. The air distribution system should be constructed of materials suitable for the intended temperature of operation. Schedule 80 polyvinyl chloride (PVC) piping and valving of chlorinated polyvinyl chloride (CPVC) are suitable for most copper applications. Note, some nickel plating applications operate at a constant 140 °F and therefore PVC piping components are not recommended. When high temperatures are expected materials of construction should be selected from suitable stocks of polypropylene, copolymers of polypropylene, or polyvinylidene fluoride (PVDF). It is also noteworthy to mention care in the addition of concentrated sulfuric acid to still copper plating tanks. The addition of concentrated sulfuric acid should only be made in small increments to tanks with the air agitation on, in order to avoid localized overheating at the bottom of the tank in the sparger zone. Localized overheating and warping of otherwise well designed sparger systems has been the cause of poor agitation uniformity.

The air agitation distribution piping in the plating tank must be leveled and weighted to ensure accurate placement of the pipe runs beneath the cathodes. It is advisable to install the sparger approximately 2 inches above the tank floor in order to avoid disturbing and suspending otherwise sedentary particulates on the bottom of the tank. Plastisol coated weights can be effectively utilized as spacers and shims to level the sparger 2 inches above the floor of the tank. Mounting the sparger directly on the bottom of the tank floor is not recommended for the reasons mentioned above. Threaded pipe fittings with Teflon tape are recommended, especially for initial design construction.

Sizing the System

In order to calculate the size of the blower needed, the shape and volume of plating tank is required. The basic thumb rule for estimation purposes is 1.5 cubic feet per minute (CFM) for each effective surface square foot (ESA) of tank surface area. (See the section on definition of terms and calculations) For demonstration purposes we will design and calculate a sparger system for a plating tank length 10.5 feet, width 3.5 feet and depth 6.5 feet. The main supply header pipe should be the same I.D. as the output supply pipe size of the blower. Due to the heat generated at the blower, an interface section of flexible high-pressure stainless steel is recommended between the blower and first section of plastic piping. Observe the recommendations for flow capacity when sizing the header manifold piping from the blower to the in-tank sparging lines. This will ensure that adequate and uniform flow will reach the terminal ends of the in-tank lines, typically 0.75 or 1.0 inches in diameter for most tanks.

Designing the System

Definition of Terms

A	= Pipe Losses
AC	= Anode distance center to center in feet
B	= Number of holes
C_1	= 0.47 CFM (Air flow volume through 3/32 inch diameter hole)
C_2	= 0.86 CFM (Air flow volume through 1/8 inch diameter hole)
CFM	= Flow volume in cubic feet per minute
D	= Density the specific gravity of the solution
Dp	= Differential pressure at the exit hole
ESA	= Effective surface area in feet squared
H	= Height, depth of the solution in feet
K_1	= 1.5 CFM/ft^2 ESA for Bright Acid Copper
K_2	= 1.0 CFM/ft^2 ESA for Bright Nickel
L	= Length of the tank in feet
P	= Pressure of the blower in pounds per square inch

Basic Assumptions

Dp = 0.25 psi

A = 0.50 psi

Basic Formulas for Air Flow Calculations

ESA = AC x (L – 0.5 ft)

P = 0.433 x H x D + A + Dp

CFM = ESA x K

B = CFM/C

Example

Calculate Effective Surface Area, Pressure, Cubic Feet per Minute and Number of holes required for an Acid Copper plating tank 10.5 feet long, 3.5 feet wide and 6.5 feet deep.

And where AC = 3.0 feet   D = 1.20   Dp = 0.25 psi   A = 0.50 psi

ESA = 3.0 x (10.5 – 0.5) = 30.0 ft^2

P = 0.4333 x 6.0 ft x 1.20 sp.gr. + 0.5 + 0.25 = 3.87 psi

CFM = 30.0 ft^2 (ESA) x 1.5 CFM/ft^2 = 45.0 CFM

B = 45.0 CFM / 0.47 CFM per hole = 96 holes 3/32 inch diameter

Air Flow CFM versus Pipe Diameter

I.D.	Max CFM
0.75 in.	8
1.0	12
1.5.1	27
2.0	60
2.5	90
3.0	150
4.0	250
6.0	650

Air Flow CFM versus Differential Pressure per Hole

Dp Hole	CFM			
	3/32 Hole		1/8 Hole	
	¾ Dia.	1.0 Dia.	¾ Dia.	1.0 Dia.
0.25 psi	0.47	0.56	0.86	1.06
0.50	0.58	0.67	1.05	1.26
0.75	0.68	0.77	1.23	1.46
1.00	0.79	0.88	1.42	1.67
1.25	0.89	0.97	1.60	1.87