Air Agitation Systems

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Several factors should be taken under consideration prior to the actual installation of an air agitation system. Heating equipment, if just adequate, should be re-examined because air flowing through the solution will produce some cooling that will necessitate additional heat to maintain temperature. Filtration equipment should be capable of solution turnover at least once every hour. Consideration should also be given to the solution level with respect to surface agitation and the possibility of corroding the anode hooks. Preventing the anode hooks from corroding can be accomplished in several ways, including lowering the solution level, raising the anodes by installing shorter hooks, or fabricating from some other type of metal, such as titanium. Anode bus bars should be at least 10 cm (4 in.) from the surface of the solution with the air on. Choice of equipment in contact with the solution should be determined from the standpoint of compatibility with the solution, corrosiveness of the solution, and temperature of the solution. If addition agents (that produce foaming) are being used in the operation, a leach operation (using a warm, 1 - 2% HCl solution) should be performed to minimize the quantity of these agents absorbed in the tank lining and accessory equipment. (Only non-foaming addition agents should be used with air agitation.) Anode bags should be replaced.

Pipe Layout

Agitation is accomplished by introducing air under low pressure through the pipe and out of the drilled holes. As the bubble leaves the hole, expansion takes place and the movement of the bubble up through the solution while expanding provides agitation. Because the expansion requires some definite interval of time and distance, the lower portions of the solution receive the least agitation. In addition, since the bubbles travel vertically through the solution, the area of greatest agitation occurs directly above the pipe. For the above reasons, therefore, it can be seen that allowance (25 cm or 10 in.) should be made for bubble expansion and pipe placement should be directly under the work, if the agitation system is to be used to the fullest advantage. Agitation under or near the anodes should be avoided to prevent roughness.

The number and location on the air pipes on the floor of the tank will vary in each installation. The governing factors will be the location of the parts in the tank and the width of the parts or racks being plated. Present and future requirements should be taken under consideration when determining these factors. Header piping, used to furnish the air to the spider on the floor of the tank, is another factor that will influence the uniformity of agitation over the entire surface of the tank.

Number of Pipes

In general, one air pipe will provide agitation for 7.6 cm (3 in.) on either side of the perforated pipe. The number of pipes to be used, therefore, will depend on the area to be agitated, generally, the width of the rack and the length of the tank. Present and future requirements should be considered when deciding on the number of pipes. The width of the widest rack should always be the basis for determining the number of perforated pipes. Where the rack width varies considerably, the number of pipes should be sufficient to cover all situations. For example, a single pipe would be satisfactory for agitating a relatively narrow rack as shown in Fig. 1a. The two-pipe system shown in Fig. 1b is also satisfactory, if only parts racked as shown are plated. If the rack in Fig. 1a were to be plated in the two-pipe system shown in Fig. 1b, the rack would fall into the relatively unagitated zone bounded by "B" and the degree of agitation is lessened. Obviously, a third pipe, "C", should be included if both types of racks are to be used.

In full-return semi-automatic equipment where the conveyor negotiates a curve during the plating cycle, it may be necessary to provide additional pipes to fully cover the area in the arc produced by the "swingout" of the rack around the curve. In similar areas in full-return automatic equipment, it is generally necessary to agitate only those areas which the machine indexes. In special equipment, such as

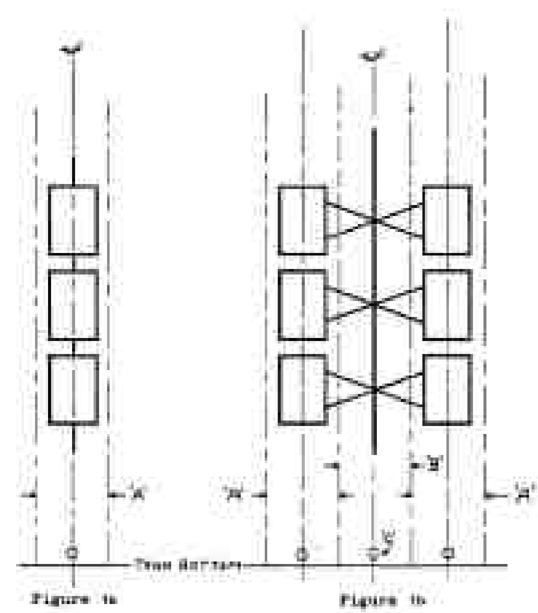

Fig. 1—"A" is zone of greatest agitation equal to approximately 15 cm (6 in.). "B" is zone of least agitation equal to 15 cm or more.

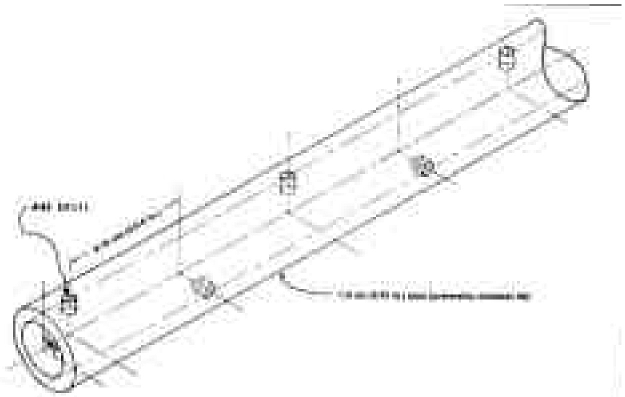

Fig. 2—Section of perforated pipe. (Note: Pipe shown in this position for clarity. Actually, installation should have included the angle directly shown.)

cell plating tanks (used in the plating of bumpers), it is necessary to provide piping that will conform to the shape of the articles being plated.

If there is any doubt as to whether an additional perforated pipe is necessary, always bear in mind that more than adequate agitation is better than too little.

Hole & Pipe Size

Piping fabricated from synthetic materials should not warp or soften under the temperatures involved. Otherwise, drilled holes will have a tendency to close and agitation over the length of the tank will be uneven.

The size and location of the drilled holes is preferably 2.4 mm (3/32 in.) in diameter (#42 drill), spaced 7.6 to 10 cm (3-1/2 to 4 in.) apart and staggered at 90° (Fig. 2). The diameter of the synthetic pipe is determined from the cross-sectional area of the pipe which should be equal to 1-1/2 to 2 times the *total* cross-sectional area of all drilled holes in the pipe. Preferably, the perforated pipe is fabricated from 1.9 cm (3/4 in., schedule 80 [.154 in. wall]) stock. Accordingly, the longest single length of this pipe that could be used, and still meet the above requirements, would be about 3 m (10 ft). However, this length of unsupported synthetic pipe in hot solutions is subject to warping, so lengths should be limited to 1.8 m (6 ft) or less. The overall length of perforated pipe sections containing elbow fittings should be shorter to maintain uniformity of agitation. Previous discussion has shown the relatively narrow range of agitation provided by a single pipe. Changes in dimensions produced by warping should not be looked upon lightly. When installing the perforated pipe, the angle included by the two rows of holes should be placed directly down so that the holes will be on a 45° angle from the vertical and facing down. All holes should be deburred and the pipe cleaned prior to assembly.

Placement of the pipe on the floor of the tank will vary with the individual installation. However, most installations can follow the example shown in Fig. 3. In this diagram, the section shown as a solid line represents a single-lane installation, and a double-lane installation is represented by both the solid and broken lines. Installations having more than two lanes preferably have the air supply entering from both sides of the tank. Header-pipe diameters will vary according to the number of perforated pipes; the greater the number of perforated pipes, the larger-diameter header pipe is required for uniform air distribution. Appropriate sizes are listed in Table I along with the maximum number of lateral perforated pipes per lane. The header-pipe diameters are based upon a header-pipe cross-sectional area slightly larger than the total cross-sectional area of all the connecting lateral perforated pipes.

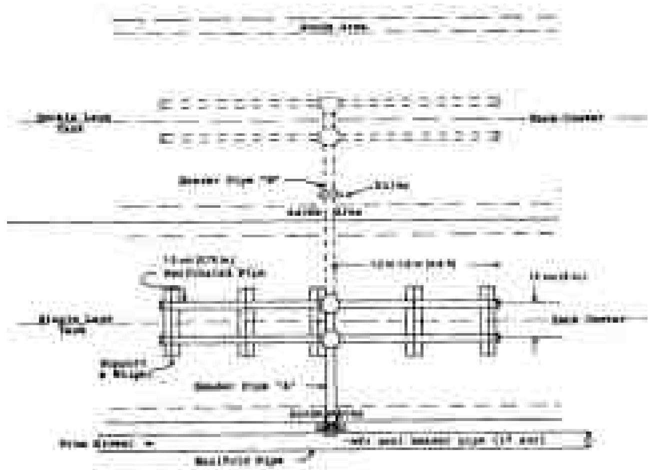

Fig. 3—Pipe and manifold layout for straight tank.

Assembly

Assembly of the spider can be made by using threaded pipe and fittings or special adhesives. Each assembly system has distinct advantages. The threaded system should be given consideration from the standpoint of easier replacement of the pipe even though the initial installation cost is higher. A union can be placed as shown in Fig. 3 to provide maximum flexibility in the event that the far portion needs replacement or repositioning. The vertical portion of the header pipe should always be fabricated using threaded pipe and fittings. If the tank has a sloping bottom, *care should be taken to insure that all perforated pipe is installed on the same horizontal plane.* This can be accomplished by varying the height of the coil weights (explained later).

Where more than one header pipe is used, the air from the blower must be distributed uniformly to the header pipes by means of a manifold pipe (see Fig. 3). The size of this pipe will also be determined by the number of connecting header pipes. An example of sizes is given in Table 2. The manifold pipe can be fabricated from steel pipe.

If the number of header pipes is great (*e.g.*, more than four), the blower should be connected to the geometric center of the connecting header pipes. Valves should be provided near the point where the header pipe exits from the plating tank so that adjustment of the agitation from a given spider can be controlled visually.

Air Supply

The air supply should be from a blower providing filtered oil-free air. The filter must be of the dry-screen type. Compressed air should definitely not be used. The blower must be large enough to provide pressure at 1.0 psi for each 48 cm (18 in.) of solution depth. The blower should have a volume capacity of 0.03 m^3/min (1.0 cfm) for each 30.5 cm (one ft) of immersed perforated pipe. Agitation for rinses and the like, if contemplated, should be provided for when selecting the blower size as well as any future requirements for additional volume. For example, in Fig. 3, if each perforated pipe were 1.5 m (5 ft) in length, 0.6 m^3/min (20 cfm) would be required for a single lane and l.2 m^3/min (40 cfm) for the double-lane tank. The blower is preferably mounted well above the solution level to prevent any siphoning action when the blower is turned off. If the blower is mounted below solution level, provision should be made for the installation of an anti-siphon device. A satisfactory anti-siphon procedure uses a 0.8 or 1.2 mm (1/32 or 3/64 in.) hole drilled in the uppermost portion of the header pipe. An adjustable pressure regulator and relief valve is generally supplied with the blower but should be installed in the event it is not.

Table 1 - Header pipe sizes for 1.9 cm (3/4 in.) perforated pipe

	Header Pipe "A"	Header Pipe "B"	Max. No. of Connecting Lateral Perforated Pipes
Single Lane	3.8 cm (1.5 in.)	-----	4
Double Lane	5.0 cm (2.0 in.)	3.8 cm (1.5 in.)	8 (4 per lane)
Single Lane	5.0 cm (2.0 in.)	-----	6
Double Lane	6.5 cm (2.5 in.)	5.0 cm (2.0 in.)	12 (6 per lane)

Miscellaneous

Weights

Unless weighted, the spider of perforated piping will have a tendency to float. Suitable weights can be fabricated from "tee bar" stock protected with a heavy rack coating. The weight also serves the dual purpose of minimizing pipe warping. Tanks with sloping bottoms will necessitate weights of varying height. Weights are preferably spaced approximately 0.6 to 0.75 m (2 to 2-1/2 ft) apart as shown in Fig. 3.

Anode Bag Weights & Guards

Because of the increased agitation in the tank, the sludge area at the bottom of bagged anodes will have a tendency to "float." The "whipping" of this portion of the bag can result in puncture of the bag by the anode sword, or by the racked articles. To prevent this, either weights or anode guard screens can be used. The anode bags can also be tied together, but this hinders replacement. Screens have the disadvantage of contaminating the solution, if a break in the coating should occur, and produce added difficulty in the event of a dropped rack, which may snag the screen. It has also been reported that increased voltage is necessary becaus of the presence of screens. Weights are preferably used, and can be fabricated from anode stubs or 5 to 7.5 cm (2 to 3 in.) lengths of anode. Either should be suitably rack-coated or otherwise protected with approved non-contaminating materials such as glass, ceramics, etc. These are then dropped in the bottom of the bag and retrieved when the bag is discarded. To further minimize the above conditions, air in the vicinity of the anodes should be avoided.

Protective Screens

The presence of the air pipes on the bottom of the tank will make raking for dropped work difficult and may result in snagging and breaking of an air pipe. Suitably rack-coated screens fabricated from expanded metal can be placed over the air pipes on the coil weights where dropped parts are prevalent. However, the best way to prevent dropped parts is to insure that the work is racked securely. Screens are recommended at the load and unload ends of automatic and semi-automatic equipment.

Typical Installation

As an example of a typical installation, assume it is desired to install air agitation in a semi-automatic plating unit of approximate dimensions 6 X 1.5 X 1.4 m (20 ft long, 5 ft wide and 4-1/2 ft deep) containing approximately 11,400 L (3,000 gal) of plating solution (see Fig. 4). The example is chosen to illustrate the installation of piping along straight and curved portions of a tank.

The present operation may use racks that extend very close to the bottom of the tank. Because the perforated pipe will not rest on the bottom of the tank, and the lower portions of the solution will be relatively unagitated, the articles to be plated should be no closer than 305 mm (1 ft) from the tank bottom.

The first step in installing the air agitation is to decide on the number of perforated pipes to be used. In the example, it will be assumed that the width of the widest rack is not greater than 15.2 cm (6 in.) and, therefore, a single perforated pipe will suffice. The pipe will be installed directly under the cathode bus bar, which in this case is also the conveyor. The bus bar follows a semi-circle (Radius "R") at both ends of the tank and the pipe will conform to the cathode bus bar. (Rack widths up to 30.5 cm [1 ft] can be accommodated with a two-pipe system having pipes located 7.6 cm [3 in.] on each side of the single- pipe position shown in Fig. 4. "R" for the inner pipe is now, R - 7.6 cm [R - 3 in.] and for the outer pipe, R + 7.6 cm [R + 3 in.]).

The second step is to determine the number of header pipes. Since the tank is 6 m (20 ft) long and the preferred longest length of perforated pipe operating from one header pipe is 3.7 m (12 ft) (see Fig. 3), it will be necessary to use at least two header pipes to supply the perforated pipes with air. In the example, two header pipes each supplying approximately 3 m (10 ft) (1.5 m [5 ft] on each side of the header pipe) of perforated pipe (dimension "P") were chosen. It was also decided, for maximum flexibility in adjusting the air supply to use two pairs of header pipes with each half of the tank (one-pair header pipes) being supplied with air from separate manifold pipes, both manifold pipes being supplied from the same blower (not shown). (An alternate method is to use a manifold pipe on one side only and supply the air to the perforated pipe in the opposite lane by submerged header pipes as represented by the dotted lines according to Figs. 3 and 4.)

The total length of 1.9 cm (3/4 in.) perforated pipe to be used is approximately 12 m (40 ft) (6 m [20 ft] per lane) and 3.8 cm (1-1/2 in.) header pipe is fabricated to suit the individual need (see Table I). The 6.4 cm (2-1/2 in.) manifold pipe can be fabricated from steel pipe. Appropriate valves are to be installed where the header pipe leaves the solution. Enough coil weights should be fabricated to provide support at every 0.6 m (2 ft) of perforated pipe. The piping for the curved portion of the tank can be fabricated by using a series of 45° bends. Because pressure drops occur where the air in the perforated pipe passes through a bend, the number and angle of the bends should be kept to a mini-

Table 2—Manifold pipe size

Manifold Pipe Size	Max. No. of Header Pipes (In-line)		
	3.8 cm (1.5 in.)	5.0 cm (2.0 in.)	6.5 cm (2.5 in.)
3.8 cm (1.5 in.)	1	Do not use	Do not use
5.0 cm (2.0 in.)	1	1	Do not use
6.5 cm (2.5 in.)	2	1	1
7.6 cm (3.0 in.)	3	2	1
10 cm (4.0 in.)	6	3	2
15 cm (6.0 in.)	13	7	5

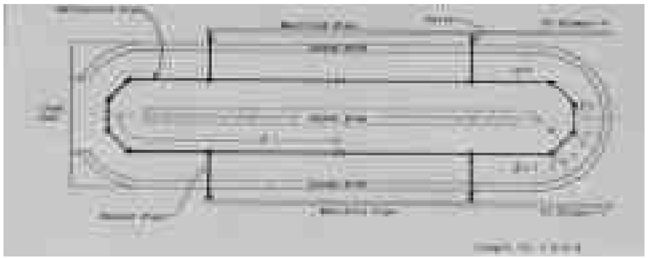

Fig. 4—Typical semi-automatic installation.

mum. The length "L," shown in Fig. 4, is actually the side circle of radius "R" (in this case the radius of the conveyor) and can be determined from the formula L = 5/6 R.

The next step is to calculate the blower size. Since 0.03 m^3/min (1 cfm) of air is required for each 30 cm (1 ft) of perforated pipe at a pressure of 1.0 psi for each 45 cm (18 in.) of solution depth, the size of the blower in this case is 1.2 m^3/min (40 cfm) at 3 psi. Consideration for extra blower capacity in the event rinses and the like will be air-agitated should also be provided for when selecting the blower size. ***P&SF***

Editor's note: The preceding article is based on material contributed by Louis Gianelos for the "AES Update" series that ran in this journal in the late 1970s and early 1980s. Since this article was written, much has changed. Yet, much remains relevant and the reader may benefit both from the information that remains relevant, and the historical perspective of the technology in 1978. "The Update" series, was begun and coordinated by the late Dr. Donald Swalheim, to bring practical information to the metal finisher. In some cases here, words were altered for context.