General Considerations for Construction and/or Renovation of Anodizing Facilities

Angela M. Vawter, Burns & McDonnell, Kansas City, MO

Anodizers must face special considerations when implementing new process lines and equipment. Building features, architectural coatings, ventilation, building and process heating, fire protection, life safety, utilities, material and chemical handling, and agitation methods are just some of the areas that deserve special attention. Whether building a new facility or renovating an existing facility, it is important that anodizers are aware of their special needs and the options available today to address those needs. This presentation will serve as an elementary checklist of concerns for anodizers facing the ambitious task of building a new facility or renovating an existing facility.

For more information, contact:
Angela M. Vawter, PE, CEF
Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Phone (816) 822-3221
FAX (816) 822-3513

Introduction

"In the middle of difficulty lies opportunity." – Albert Einstein

The world of anodizing is ever changing. Anodizers adapt to this change by physically expanding operations to meet increased volume demand, and/or modifying operations to meet new product demands. This adaptation takes many forms, but breaks down into two major categories: (1) the construction of a new facility from the foundation to the roof with new processes, equipment, etc., and (2) the renovation or modification of an existing facility, where new processes and equipment are implemented within existing construction

Since new construction and renovation are ambitious undertakings, firms wishing to ensure success will seek the services of a professional architectural and engineering firm. Reputable A/E firms will be familiar with not only the building, fire, mechanical and plumbing codes, but will address such often overlooked items as building egress (see the *Building Egress* section). As Ralph Waldo Emerson so succinctly stated, "Skill to do comes of doing."

Consultation with the firm should begin early in the planning stages, with firms carefully evaluated for their experience in the metal finishing industry and their knowledge of new anodizing process lines and equipment. During the planning process, special consideration must be given to everything from the floor to the roof. A checklist of key concerns (Table 1) may be helpful to the anodizer during the planning and design phases of the project. The following pages discuss the issues listed in Table 1.

Table 1
Example Checklist of Construction and Renovation Concerns for Anodizers

Issues	Yes	No	N/A
Building Related Issues:			
Is noise level at the property line a concern?			
Is aesthetics a concern?			
Is a masonry or concrete building required?			
Is a metal building allowable?			
Is a pit or piping gallery allowable?			
Will the operation require a pit or piping gallery?			
Will the height of the operation fit within the height of the existing construction?			
Should the height of the building be increased?			
Architectural Issues			
Has the layout of the new facility been carefully considered?			
Have the architectural coatings been addressed?			
Will metal grating be required?			
Will FRP grating be required?			
Material Handling Issues			
Will the process be automated?			
Has adequate space been provided for material handling?			
Has adequate space been provided for chemical storage?			
Has adequate space been provided for raw material storage?			
Has adequate space been provided for product storage?			

Table 1
Example Checklist of Construction and Renovation Concerns for Anodizers

Issues	Yes	No	N/A
Has adequate space been provided for staging?			
Ventilation and Heating Issues			
Should push-pull ventilation be provided?			
Should pull-pull ventilation be provided?			
Should automatic tank covers be provided?			
Should a travelling exhaust hood be provided?			
Has makeup air been addressed?			
Has heating been addressed?			
Is a scrubber required?			
Is a mist eliminator required?			
Have the appropriate materials of construction been provided?			
Fire Protection and Safety Issues			
Will an automatic sprinkler system be provided?			
Has a fire chief provided exemption from sprinkler requirements?			
Will explosion control be required?			
Has building egress been addressed?			
Have safety showers and eyewashes been provided in locations convenient to chemical hazards?			
Has tempered water been provided for showers and eyewashes?			
Electrical Issues			
Is the existing electrical service adequate?			
Have the rectifiers been properly chosen?			
Have the rectifiers been properly located?			
Has bussing been adequately sized?			
Has lighting been addressed?			
Process Heating Issues			
Will steam heating be required?			
Have condensate issues been addressed?			
Will electric heaters be required?			
Have temperature sensors, controllers, and heating devices been properly coordinated?			
Process Agitation			
Will air agitation be provided?			
Will agitation blowers be provided?			
Have provisions for clean air been provided?			
Will agitation pumps be provided?			
Will a mixer be provided?			
Will workbar agitation be provided?			

Structural Features

"Give me where to stand, and I will move the earth." – Archimedes

Facility renovation tends to be more challenging than new construction. New construction can be fashioned to conform to the requirements of the processing and manufacturing operations and future expansion. Renovation often dictates that the new processing and manufacturing operations conform to the constraints of the existing building. If the project includes new construction, the anodizer must consider the type of building that is needed to meet current and future needs. Other structural issues, such as secondary containment and roof height, are important for both new construction and renovation.

Building Types

Buildings that house anodizing and manufacturing processes fall into two major categories: concrete and metal. In this context, concrete buildings refer to structures of masonry block, cast-in-place concrete, or precast concrete. Each of these types has its own advantages and disadvantages. However, common advantages to well-maintained concrete buildings include durability, corrosion resistance, noise reduction and aesthetics.

As cities become more populated and residential and industrial areas grow closer together, industry has begun to feel pressure to reduce the noise that emanates from facilities. Concrete walls and roofs provide natural noise reduction beyond the facility.

The term "aesthetics" commonly refers to "beauty". Most anodizers would agree that their facilities are not required to be "beautiful". But the appearance of any facility should be acceptable to the beholder, whether it is a neighbor or a client. In the case of military bases, new construction often must match the façade of surrounding buildings. When aesthetics are of special concern, concrete buildings tend to offer more opportunities for pleasing the eye than metal buildings. Concrete buildings can even evoke an image of stability and success, if properly designed.

In this discussion, metal buildings are considered to be either custom-designed steel framed buildings or pre-engineered metal buildings. Most metal buildings offer less noise reduction than concrete buildings and, to some people, are not as visually attractive. They are also not as durable in corrosive environments. Metal buildings require expensive coatings in order to successfully house anodizing operations for long periods of time. If the coatings are factory applied, the steel members and panels require special handling to protect the coatings during construction. Yet anodizers have chosen metal buildings over the years because of their lower cost when compared to concrete buildings.

Secondary Containment

Secondary containment, the process whereby chemicals that escape the confines of the processing tank are contained, is a requirement for anodizing operations. There are two major forms of secondary containment. The first form is the containment pit and the second form is the containment trench.

A containment pit (as shown in Figure 1) is essentially a recessed area of the workspace in which the process tanks will reside. There are several important factors to consider during the design of the pit:

1. The pit must be sized to hold the contents of one tank, plus a 20 minute flow from the automatic sprinkler system.[1]

2. The pit must be made water tight and corrosion resistant with liners or coatings (see the *Architectural Coatings* section).
3. The size of the pit should allow for maintenance of the tanks, utilities, and piping.
4. The tanks should be placed in the pit in a way that allows the top of the tanks to be at least 42 inches above the working surface[2] to protect workers from accidentally entering the tank. In other words, H1 (as shown in Figure 1) must be 42 inches or more.
5. The pit should be covered with grating (as shown in Figure 1) to prevent accidental falls and injuries.
6. If the new pit is going to be placed within an existing building, the building footprint must allow for the pit excavation.
7. The pit excavation must not interfere with the building's foundation system. Otherwise, special construction techniques will be required during excavation.
8. Pit construction should consider that tanks should not be placed directly on the floor (as shown in Fig. 1).

An architectural and engineering firm should be consulted for pit design, especially if the pit is being placed in an existing building. Original foundation and building drawings should be provided to the firm for use during design.

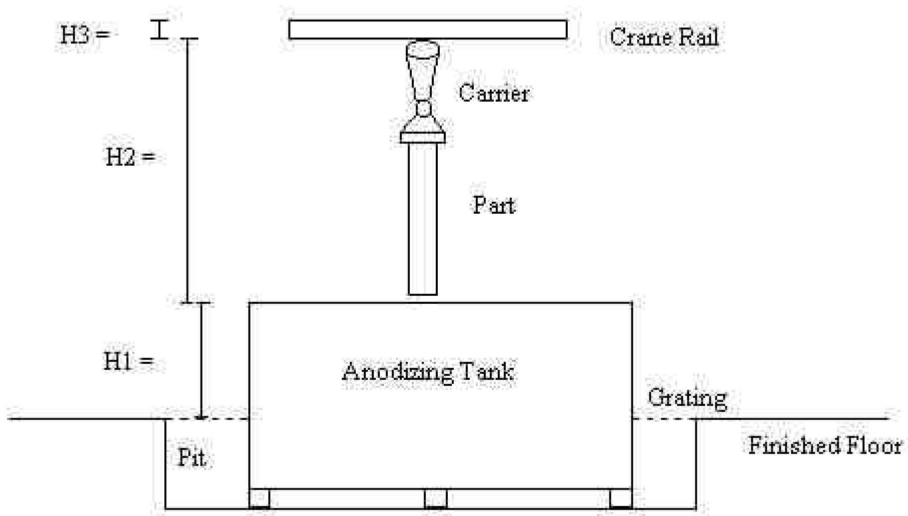

Fig. 1 – Simplified Section of Anodizing Tank Line.

A containment trench is a trench located around the perimeter of the tank line that receives escaping chemical and drains the chemical to a containment pit or tank. There are several important factors to consider during the design of the trench. First, the trench must be placed so that it can receive chemical, not only from a leaking tank, but also from an overflowing tank. This can be accomplished by sloping the floor toward the trench, and placing it a few feet away from the tank line on all sides. Second, the trench must slope toward the containment pit or tank. Third, the trench must be made water tight and corrosion resistant with liners or coatings (see the *Architectural Coatings* section.) Fourth, the trench should be covered with grating to prevent accidental falls and injuries.

Roof Height
Whether building a new facility or facility addition, or renovating an existing facility, roof height is an important consideration. The inside clear height of the building must exceed the height of the processing tanks above the finished floor, plus the height of the part and the height of the part carrier and crane rails, as shown in Equation 1. (See Figure 1 for a description of H1, H2, and H3.)

$$(1)\quad \text{Inside Clear Building Height} > H1 + H2 + H3$$

In the case of renovation, if the height of the process will not fit under the existing roof, the roof will have to be raised. This can be costly and, in some cases, may exceed the cost of construction of a new building.

Architectural Features

Overall Layout

The proper layout for workflow within a processing facility is essential to efficient production. The proper layout should be developed early in the planning stages of the project. It is much less costly to develop an efficient layout during the planning stages than it is after construction.

Many anodizers perform functions other than anodizing. It is important that these (and all) anodizers plan their facilities so that successive processes are placed as adjacent to each other as possible. What is true for an anodizing line layout is true for the rest of the anodizing facility: "travel time = money". As an example, the movement of material through receiving, stamping or punching, racking, anodizing, inspection, subsequent coatings, unracking, inspection, packing and shipping should be as direct as possible with little or no backtracking or crossing of paths, except for the case of rework. A professional architectural and engineering firm can assist in the development of the most efficient layout of the facility.

Architectural Coatings

All anodizing processes are corrosive by nature. Corrosive processes can take a toll on walls, floors, metal grating, structural steel, and even ceilings and roof structures (if not ventilated properly). Corrosion of these building elements can be hindered or abated via use of architectural coatings. Coatings should be properly chosen considering the following criteria:

- Architectural Substrate (Metal or Concrete)
- Chemical Exposure (Phosphoric Acid, Sulfuric Acid, Chromic Acid, etc.)
- Application (Wall, Floor, etc.)
- Temperature

Because anodizers tend to work with more than just one chemical process, a good all-purpose coating can be applied such as a vinylester resin coating. Coatings, such as vinylester resin, can be purchased as resilient (resinous) floor coatings, coatings for structural steel and wall coatings. Because vinylester resins are typically more expensive than most wall paints, they should be used only where needed. For example, in a well- ventilated shop, they can be applied from floor level to 8 feet above the finished floor or where chemical splash may occur. Before choosing any coating, make sure that the coating manufacturer is aware of each and every chemical that may be contacting the coating. This extra precaution will ensure that the best coating will be provided for the application.

Grating Types

Grating is typically used as the walking surface in an anodizing shop if the tanks are recessed in a pit (as shown in Figure 1) or if the tanks are accessed by a raised platform. The two major types of grating used in facilities today are metal and plastic.

Metal grating is usually constructed of steel, which has two major drawbacks. First, the grating is not inherently corrosion resistant and will require a coating (and maintenance of that coating) for long term use in an anodizing shop. Second, steel grating is not resilient and will warp after years of use or if overloaded. Grating is foremost manufactured for foot traffic. Operators, however, will frequently place a piece of heavy equipment on the grating, which distorts and warps it. After years of use, the walking surface can become a treacherous path of bumps and dips.

Plastic grating is constructed of glass fiber reinforced plastic (FRP). When properly specified for the application, the FRP grating will be corrosion resistant to the processing chemicals, and will be essentially maintenance free. FRP also tends to be more resilient than steel, and will resist warpage when temporarily overloaded. FRP is resistant to most corrosives, but is not recommended for use when the application involves hydrofluoric acid, ammonium bifluoride, and some solvents.

Material Handling

"The man who does not give up can move mountains." – Earnest Hello

Material handling is an important part of any manufacturing process. As mentioned in the *Overall Layout* section, the proper overall layout of the facility is essential to efficient production. It is particularly critical to efficient material handling including product, raw material, and chemical handling. During the design process, adequate space must be allotted for movement of fork trucks or other means of material handling to, from and through the processing space. The designer must understand the means of material movement through the facility including turning radius; width, height, and weight of load; and frequency of transport. If the process is automated, the designer must understand how to integrate various pieces of material handling equipment such as bridge cranes, power and free conveyors, monorails and/or automated transfer vehicles (ATVs).

The design of the facility must also incorporate adequate space for staging of raw material, storage for raw material and product, and storage for chemicals. These spaces should be easily accessible to shipping and receiving docks.

Ventilation and Heating

"Ventilation is an art and not a science." – Bob Hoisington, P.E.

Exhaust System

All anodizing processes should be provided with an exhaust system. Exhaust is necessary to capture and remove harmful fumes, mists, moisture, and heat from the workspace. Fumes, moisture and heat are detrimental to workers' health and the welfare of the building. Exhaust systems should be designed to meet the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH) in the publication *Industrial Ventilation*: *A Manual of Recommended Practice*. The publication provides equations and tables for calculating the amount of exhaust required from a processing tank based on chemicals, temperature, type of process, size of tank and type of ventilation system. The two major denominations of ventilation considered in the publication and commonly used in the anodizing industry are pull-pull and push-pull. Pull-pull ventilation utilizes two or more exhaust hoods situated on opposite sides of the tank. (See Figure 2.) Essentially, if two hoods are utilized, each hood exhausts ½ of the surface area of the top of the tank. The volume of air exhausted must be such that sufficient capture velocity is present to remove contaminants.[3] Push-pull utilizes an exhaust hood and a push-air header. (See Figure 3.) The push air sweeps across the tank and pushes emissions toward the exhaust hood.[4] The exhaust hood functions to capture and remove the push-air and not to provide capture velocity.[5] This second method is typically more effective per cfm of air and requires substantially less exhaust air, which translates to smaller ductwork, exhaust fans and smaller scrubbers. However, it does require push air blowers and air piping. Unfortunately, push-air ventilation is not well suited for barrel plating or processing of large solid parts. Large solid surface areas tend to deflect the push-air while parts are being lowered into and raised from the tanks. The push-air deflection allows emissions to escape the grasp of the exhaust hood.

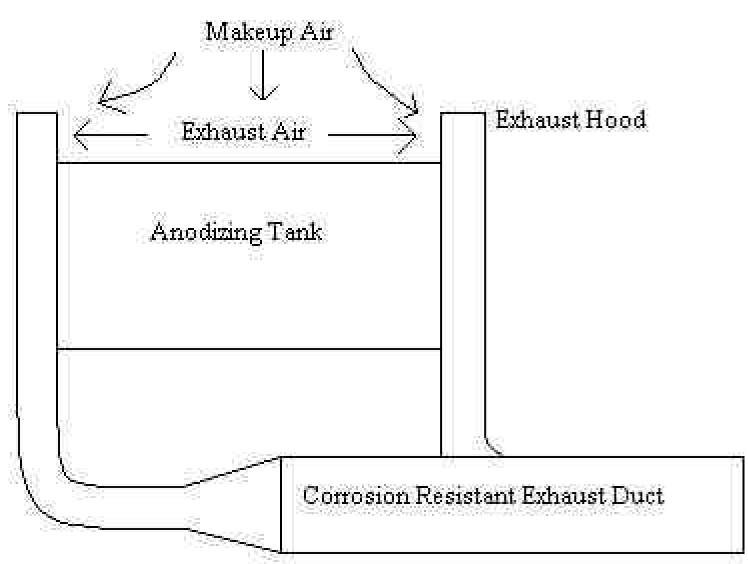

Fig. 2 – Simplified Section of Pull-Pull Ventilation

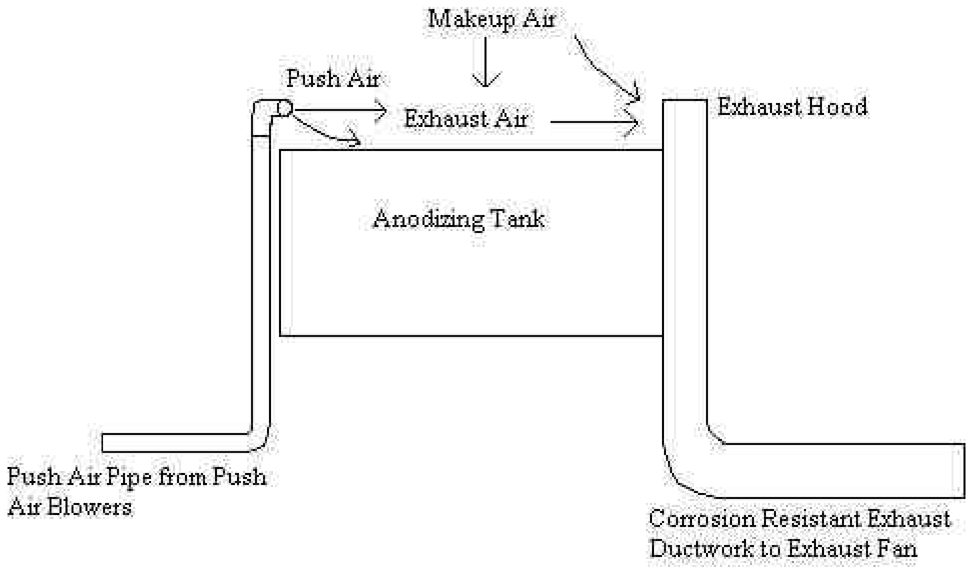

Fig. 3 – Simplified Section of Push-Pull Ventilation

The metal finishing industry, including anodizing, is leaning towards the use of automated tank covers with interlocking ventilation systems. Using covered tanks drastically reduces the exhaust air required which, as stated previously, reduces ductwork sizes, fan sizes, motor sizes, and scrubber sizes. This translates to lower utility costs and even capital costs when comparing a covered tank line to a non-covered tank line. The reduced exhaust rate is accomplished by only exhausting the tank with the open cover at its full capacity. All closed tanks are exhausted at a fraction (usually 10 percent) of their full capacity (as required by ACGIH). A tank will only be open when a part is raised or lowered from the tank. The tank will be closed while the part remains in the tank. The number of open tanks is governed by the number of hoists on the line available to pick-up or drop-off parts at the same time.

A wise design enhancement in metal finishing exhaust is a "traveling exhaust hood". This exhaust hood (typically used in conjunction with automated covered tanks) encloses the hoist and captures fumes from the part as it travels from process tank to process tank. Benefits of the enclosure include reduced building corrosion and a significant reduction in fugitive emissions. This hood was developed for phosphoric anodizers, but it can also be used for any volatile process.

Makeup Air and Heating

One aspect of metal finishing ventilation that is often overlooked is makeup air. In order to exhaust air, air must be present to exhaust. (See Figure 2.) Unfortunately, some older facilities were designed with no allowance for makeup air. Overhead doors and personnel doors are left open during mild and warm seasons to accommodate the need for air. Usually, this works well until the outdoor temperature drops below the comfort zone. At that time, the roll-up doors are rolled-down, personnel doors are closed and a mysterious dense and fume laden fog descends upon the processing line. Actually, this fog is not a mystery at all, but an accumulation of moisture and chemical that has escaped the labored breath of the starving fume hood. The moral of the story is that adequate makeup air is essential to the proper functioning of the process exhaust system.

Makeup air can be provided by a number of methods. One method is via makeup air units. Makeup air units provide positive supply air to a space. These units can be roof, ground, or mezzanine mounted and are strategically ducted to provide air to key areas. Incorrectly placed supply air diffusers can interfere with fume capture, therefore, care must be exercised with the system layout. Heaters or furnaces can be installed in these units to provide heating when required. Providing heated air to the metal finishing space is preferred to providing cold air and heating with space heaters. The former allows for even heating, and reduces cold drafts and the possibility of frozen pipes in cold climates.

An alternative to positive air supply involves the provision of air intake louvers. This method requires that the exhaust system pull fresh air through the louvers and that the louvers be strategically placed to maximize ventilation of the entire shop. Unless heating coils are installed with the louvers, the incoming fresh air will be cold. If heating coils are installed, the louvers and coils will need to be sufficiently oversized to reduce static pressure losses.

Scrubbers and Mist Eliminators

Scrubbers and mist eliminators are sometimes required for treatment of exhaust from metal finishing processes. Anodizers that process with chromic acid are required to scrub their anodizing exhaust with the most achievable control technology. Other anodizers may or may not be required to scrub, depending on the geographic and political location of the shop. The anodizer's state, city or county department of environmental protection will have the final say on whether or not a given process will require a scrubber or mist eliminator. An architectural and engineering firm can help an anodizer determine whether or not one will be required.

As a side note, many finishers with corrosive processes implement scrubbers and or mist eliminators as a sort of "good neighbor" policy. This policy provides a degree of security in a litigious society.

Material Selection

Materials of construction for the industrial ventilation system should be carefully selected. Exhaust hoods, ducts, fans, and scrubbers made with commercial and residential materials (such as galvanized steel and aluminum) will not survive in a metal finishing shop environment. The three materials most commonly used for anodizing industrial ventilation are FRP (fiber reinforced plastic), CPVC and PVC. Materials of construction should be properly chosen considering the following criteria:

- Chemical Exposure (Sulfuric Acid, Hydrofluoric Acid, Chromic Acid, Hydrochloric Acid, Solvents, etc.)
- Temperature

PVC ductwork is typically the least expensive of all three materials, however, it is unsuitable for processes operating at temperatures in excess of 140 ^{o}F. FRP ductwork can be specified with a variety of resins and the cost of the ductwork will vary with the type of resin specified. The corrosion resistance of the FRP ductwork will also vary with the type of resin specified. A ductwork manufacturer will be able to assist in the ductwork selection based on the criteria mentioned above.

Fire Protection and Safety

"As soon as there is life there is danger." – Ralph Waldo Emerson

Fire protection and safety are important issues in today's industrial climate. They protect personnel, property, and the anodizer's livelihood.

Fire Protection

The degree of fire protection required for an anodizing facility is dictated by the anodizer's insurance carrier and applicable fire codes. Most code authorities are now implementing the new 2000 International Fire Code. This code combines three codes, the Standard (Southern) Fire Prevention Code, the Uniform Fire Code, and the BOCA National Fire Prevention Code. Under this new code, any facility or space storing or using more than 500 gallons or pounds of liquid corrosive is considered an H-4 or hazardous occupancy. Even smaller quantities of chemical are required for a hazardous occupancy rating of the space if that chemical is considered water reactive, highly toxic or a Class 2, 3, or 4 oxidizer. Occupancies containing water reactives and Class 1 and 2 oxidizers are considered H-3 occupancies. [6] Most anodizing shops will be considered to have a hazardous occupancy rating of either H-3 or H-4. Under the 2000 International Fire Code, all hazardous occupancies are required to have an automatic sprinkler system unless exempted by the fire marshal having authority over the anodizer's jurisdiction.[7] If exemption from this requirement is desired, it should be sought early in the planning stages of the project. Note: Applicable fire codes should be consulted and all hazards should be addressed for all anodizing shops. The information contained herein is simply an example.

The code also requires a means of explosion control for water reactives and liquid oxidizers often found in anodizing shops.[8] See Table 2 for examples of chemicals common to anodizing facilities and the hazards associated with those chemicals. The hazards are based on information and hazard definitions provided in the 2000 International Fire Code.

Table 2
Chemicals Common to Anodizing Facilities
And The Chemical Hazards

Chemical	Hazard
Sulfuric Acid	Class 2 Water Reactive
	Corrosive
Chromic Acid	Class 2 Oxidizer
	Corrosive
Phosphoric Acid	Corrosive

Building Egress

"Egress" is defined as a place of exit. Building egress is an important life safety consideration for a building renovation or new construction. Adequate egress is essential to the safe evacuation of personnel from an anodizing facility in the case of fire or hazardous chemical accident. As discussed above, many code authorities are now implementing the new 2000 International Building Code. In this new code, any operation storing or using more than 500 gallons or pounds of liquid corrosive is considered an H-4 or Hazardous Occupancy. Even smaller quantities of chemical are required for a hazardous occupancy rating of the space if that chemical is considered water reactive, highly toxic or a Class 2, 3, or 4 oxidizer. Most anodizers would fall into this category. Two exits are required where the number of occupants exceeds three (3) or the area exceeds 300 ft^2 within an H-3 occupancy or where the number of occupants exceeds ten (10) or the area exceeds 1000 ft^2 in an H-4 occupancy. At least two (2) exits are recommended, however, from any hazardous occupancy regardless of the occupancy load. For an H-4 occupancy, the maximum travel distance to the exit from the most remote point of the facility is 175 feet. For an H-3 occupancy, the maximum travel distance to the exit from the most remote point of the facility is 150 feet. Travel distance includes floor travel as well as unenclosed stairways and ramps within the space. A common path of egress travel for an H-4 occupancy is not to exceed 75 feet. A common path of egress travel for an H-3 occupancy is not to exceed 25 feet.[9] Building egress must be considered during building layout.

Safety Showers and Eyewashes

Emergency showers and eyewashes are commonplace in industry and should be located for immediate use near any chemical storage or use area. OSHA Standard 29 CFR 1910.151(c) requires the provision of emergency showers and eyewashes.[10] OSHA also indicates that the showers and eyewashes must meet the specifications set forth in ANSI Standard Z358.1-1990. ANSI has recently recommended, in the 1998 version of the standard, that all new emergency showers and eyewashes be provided with tepid water. Tepid water is defined as moderately warm water and generally considered to be water that is at 78 ^{o}F to 92 ^{o}F.[11] ANSI's reasoning is that water that is outside of the tepid range can pose health risks in some instances. Also, the victim will be more likely to rinse thoroughly for 15 minutes in water that is not severely uncomfortable. OSHA still defers to the 1990 ANSI standard that does not require tepid water. Industry belief, however, is that the 1998 ANSI standard will be incorporated into the OSHA standard in the near future.

The provision of tepid water requires an adequately sized water heater and a special automatic mixing valve. This water heater can be the same heater that serves the domestic hot water needs of the facility. However, it should be adequately sized for approximately a 30 gpm flow of tepid water for 15 minutes, in the case of a combination emergency shower and eyewash.

Electrical Service

"Genius is one percent inspiration and ninety-nine percent perspiration." – Thomas E. Edison

In the case of renovation, new anodizing lines or equipment may require a substantial upgrade to the existing electrical service. The additional electrical load induced by rectifiers, electric heat, process exhaust fans, makeup air units, push air blowers, and agitation air blowers may exceed the existing electrical system. A reputable engineering firm will address new lighting, power panels, and rectifier cable. The engineering firm can provide an investigation of the existing service to determine if an upgrade is needed then can develop plans and specifications to provide the most economical upgrade.

The engineering firm can also aid in the selection and design of the tank electrification. For proper electrification, the voltage drop from the rectifier to the tank must be minimized. The voltage drop is minimized by adequately sizing the busbars or power transmission cables.[12] The rectifier must also be properly located in a relatively clean and cool room, especially if air cooled rectifiers are selected.

Process Heating

Several anodizing processes operate at elevated temperatures (above 65 ^{o}F). These processes require heating equipment to maintain the proper temperature. The ASM Specialty Handbook, *Aluminum and Aluminum Alloys*, recommends that operating temperatures of most anodizing baths be controlled within ±2 ^{o}F.[13] The high degree of temperature control requires careful selection and coordination of temperature sensors, controllers, and heating devices.

The two most frequently used heating methods include electric immersion heaters and in-tank steam coils. ASM recommends the use of electric heaters because of their ease of use and low probability of bath contamination. ASM also recommends that the heater controls be chosen for rapid heat-up, but also accurate temperature control during processing.[14]

Electric heaters may also be more economical for small finishing operations, because the electric heat will most likely require a smaller capital investment when compared to steam heat. Steam heat will require a boiler, boiler water chemical treatment, condensate return unit with pumps, steam piping, and the steam coils. Steam heat, however, can be more economical to operate when considering the cost of natural gas compared to electricity. Critics of in-tank steam heat will cite the possibility of boiler problems if the steam coils develop leaks. When a steam coil develops a leak it will create suction and draw corrosive process fluid into the steam piping. When the hot and corrosive steam condensate is returned to the boiler, the boiler tubes will suffer corrosion and ultimately fail. There are several ways to hinder boiler failure. The preferred method is to monitor the conductivity of the condensate. If the conductivity of the condensate changes to indicate the presence of corrosives, the control system will alarm the operators of a steam coil breach and will automatically flush the steam system. Some finishing plants have opted not to return their steam condensate to the boiler system. This option requires that the steam condensate be continuously dumped and fresh water be used in the steam system. This method essentially constitutes a waste of energy and money. Because the system is continuously supplied with 100% fresh cold water, the energy required to make steam is substantially increased. Also, the chemicals used to treat the water and reduce scaling are washed down the drain.

Process Agitation

"Double, double toil and trouble;
Fire burn, and cauldron bubble." – William Shakespeare

Proper agitation is critical in anodizing processes. It is essential to keeping electrolytes and other bath elements in solution and effectively distributing heating (or cooling) throughout the tank. The recent article in *Plating and Finishing Magazine* titled *"Agitation for Anodizing: It's All about Surface Area"* recommends air agitation with a micro-PVC sparger design. The design uses spargers with drilled holes 1/16th-inch in diameter. The article explains the principle behind agitation is to maximize the wetted part surface area. Maximizing the wetted part surface area is accomplished by minimizing the size of the agitating air bubbles.[15]

Another important aspect to air agitation is ensuring that clean air is used. Particulate filters and coalescing filters will remove particulate and oil impurities from air that would otherwise contaminate the process bath.

Agitation air equipment is also of concern. Agitation air blowers that produce clean low-pressure air are preferred over industrial air compressors. During renovation, it is tempting to tap an existing plant air compressor for agitation air needs. However, plant air pressure is typically too high (100 psig and above) for use as agitation air (5 psig and lower). The plant air would require a pressure-reducing valve to reach the proper air pressure. However, this pressure adjustment essentially constitutes a waste of energy and money. Energy is used in the air compressor to increase the air pressure, and that energy is wasted when the pressure is throttled down. It is most cost effective to produce compressed air near its pressure of utilization.

Air is not the only means of agitation. Other methods include mixers and the recirculation of the process solution through external filter pumps or external cooling/heating pumps. Also, the anode workbar can be oscillated horizontally to create a "stirring" action.[16] This later method, however, does not provide agitation while the tank is between processing cycles. A second method of agitation would have to be employed to keep the solution well-mixed and eliminate heat stratification in the tank.

Summary

"Nothing in life is to be feared, it is only to be understood." – Marie Curie

Anodizers face special considerations when implementing new process lines and equipment. Whether building a new facility or renovating an existing facility, it is important that anodizers understand their special needs. Consulting a professional architectural and engineering firm is important in the success of any renovation or new construction project. The anodizer should consult with a firm that is familiar with the metal finishing industry and applicable codes because of the special considerations required to implement new anodizing process lines and equipment. Referencing a checklist of concerns may be helpful to the anodizer to ensure that all of the anodizer's needs are being addressed during the planning and design phases of the project.

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