SAFETY ENHANCEMENT IN "ANODIZING SHOP" AT FAIVELEY TRANSPORT RAIL TECHNOLOGIES INDIA LIMITED

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ABSTRACT

In today's business world, manufacturing products, with stringent Quality requirements of customers with optimized cost necessitates increased stress of employees working in the industries. That too process that involves intervention of human are critical in nature. The processes that are inspected by destruction are called "Special process", which need even more concentration during working.

Anodizing is one such special process that are related to surface coating and hazardous chemicals involving into it. The chemicals like Sodium Hydroxide, Nitric acid, Sulphuric acid should be handled carefully. They are not only dangerous to human but also to environment.

Developing a process that can eliminate or mitigate human intervention with these chemicals is good for the society and environment at large. It will lead to unbiased process as well as reduced and optimized use of them.

Thus, it becomes inevitable to improve safety in the anodizing shop through which the employees can work safely as well as productively.

1. INTRODUCTION

Anodizing shop is an important process shop in Faiveley Transport. Anodizing is essential for many parts of product system.

Let us briefly detail about the process.

It is an electrochemical process that thickens and toughens the naturally occurring protective oxide. The resulting finish, depending on the process, is the second hardest substance known to man, second only to the diamond. The anodic coating is part of the metal, but has a porous structure which allows secondary infusions, (i.e. organic and inorganic coloring, lubricity aids, etc.)

1.2.1. Anodizing Definitions and Methods

While the chemical anodizing process remains the same for all applications, the mechanical methods vary according to the two physical types and shapes of metals used:

1.2.2 Batch Anodizing

Involves racking parts and immersing them in a series of treatment tanks. Extrusions, sheets or bent metal parts, castings, cookware, cosmetic cases, flashlight bodies, and machined aluminum parts are just a few of the items that are batch anodized

1.2.3. Continuous Coil Anodizing

Involves continuous unwinding of pre-rolled coils through a series of anodizing, etching and cleaning tanks, and then rewinding for shipment and fabrication. This method is used for high volume sheet, foil and less severely formed products such as lighting fixtures, reflectors, louvers, spacer bars for insulated glass, and continuous roofing systems.

Appearance options and quality are improved using dyes and special pretreatment procedures. This makes the aluminum look like stainless steel, copper, brushed bronze or polished brass and can also be colored with brilliant blues, greens, reds, and many varieties of metallic gold and silver.

The unique dielectric properties of an anodized finish offer many opportunities for electrical applications.

The surface of the aluminum itself is toughened and hardened to a degree unmatched by any other process or material. The coating is 30 percent thicker than the metal it replaces, since the volume of oxide produced is greater than that of the metal replaced.

The resulting anodic coating is porous, allowing relatively easy coloring and sealing.

Hard Anodizing is a term used to describe the production of anodic coatings with film hardness or abrasion as their primary characteristic. They are usually thick by normal anodizing standards (greater than 25 microns) and they are produced using special anodizing conditions (very low temperature, high current density, special electrolytes). They find application in the engineering industry for components which require a very wear resistant surface such as piston, cylinders and hydraulic gear. They are often left unsealed, but may be impregnated with materials such as waxes or silicone fluids to give particular surface properties.

1.2.4 Batch and Coil Anodizing

Batch and coil anodizing are accomplished in five carefully controlled, calibrated, quality-tested stages:

Cleaning: Alkaline and/or acid cleaners remove grease, and surface dirt.

Pre-Treatment

Etching: An appealing matte surface finish is created with hot solutions of sodium hydroxide to remove minor surface imperfections. A thin layer of aluminum is removed to create a matte or dull finish.

Brightening: A near mirror finish is created with a concentrated mixture of phosphoric and nitric acids which chemically smooths the aluminum's surface.

Anodizing: The anodic film is built and combined with the metal by passing an electrical current through an acid electrolyte bath in which the aluminum is immersed. The coating thickness and surface characteristics are tightly controlled to meet end product specifications.

Coloring: Coloring is achieved in one of four ways:

Electrolytic Coloring (The two-step method) - After anodizing, the metal is immersed in a bath Anodizing Line containing an inorganic metal salt. Current is applied which deposits the metal salt in the base of the pores. The resulting color is dependent on the metal used and the processing conditions (the range of colors can be expanded by overdyeing the organic dyes). Electrolytic colors can be specified from any AAC member. Commonly used metals include tin, cobalt, nickel, and copper. This process offers color versatility and the most technically advanced coloring quality.

Integral Coloring - This so-called one-step process combines anodizing and coloring to simultaneously form and color the oxide cell wall in bronze and black shades while more abrasive resistant than conventional anodizing. It is the most expensive process since it requires significantly more electrical power.

Organic Dyeing - The organic dyeing process produces a wide variety of colors. These dyes offer vibrant colors with intensities that cannot be matched by any other paint system in the market. They can also provide excellent weather-fastness and light-fastness. Many structures built with these finishes have lasted more than 20 years. The color range can be broadened by over-dyeing the electrolytic colors with the organic dyes for a wider variety of colors and shades. This method is relatively inexpensive and involves the least amount of initial capital of any other coloring process.

Interference Coloring - An additional coloring procedure, recently in production, involves modification of the pore structure produced in sulfuric acid. Pore enlargement occurs at the base of the pore. Metal deposition at this location produces light-fast colors ranging from blue, green and yellow to red. The colors are caused by optical-interference effects, rather than by light scattering as with the basic electrolytic coloring process. Further development will produce a greater variety of colors.

Sealing: This process closes the pores in the anodic film, giving a surface resistant to staining, abrasion, crazing and color degradation.

Quality control: Throughout the entire anodizing process, Quality dept members monitor the process and quality of the product. The application of electrical power and color is preprogrammed and verified on all batches and coils.
This quality control ensures uniformity to end product specifications for film thickness, density, abrasion resistance, corrosion resistance, color uniformity, fade resistance, reflectivity, image clarity, insulative properties, adhesion and sealing.

2. LITERATURE SURVEY

Aluminum Anodizing Council on Anodizing

Aluminum Life Cycle Enhancement with Anodizing

The environmental advantages of aluminum are widely acknowledged. Aluminum is one of the most durable and versatile of metals, offering improved mileage in automobiles by virtue of its lightweight and tremendous recyclability. According to the Aluminum Association, about one-third of all aluminum produced in the U.S. today is from recycled sources, saving some 95 percent of the energy required to produce aluminum from raw materials.

Anodizing enhances aluminum and its environmental virtues. Anodizing uses the base metal - the aluminum alloy - to create a thin, extremely strong and corrosion-resistant finish. The anodized surface is very hard and thus preserves and extends the life of the aluminum product.

In contrast to anodizing, coatings - paint for example - can dramatically reduce the ability to recycle the aluminum and can increase costs. Paints, plastics, and plating rely on problematic materials in their production that can compromise green objectives. Anodizing, on the other hand, is "recycle-neutral" with minimal use of such materials as volatile organic compounds (VOCs) and heavy metals.

The corrosion resistance of anodized aluminum is well established for industrial applications. Transportation components, building elements, storage containers, and process equipment utilize anodizing to extend the life and expand the utility of aluminum structures. Anodized aluminum is safe for cookware and provides durable work surfaces for applications that require superior abrasion-resistance.

Anodizing also reduces friction and increases lubricity, an advantage with fitted components and for moving parts. Increased wear resistance means a longer life cycle. Hardcoat anodizing further improves wear resistance and general coating durability to physical forces.

Aluminum Saves Energy and Materials

Aluminum metal is a good conductor of electricity; the anodic coating is an insulator. Combinations of the two properties can be incorporated into systems that save energy and materials. The metal can serve both a structural and conductive purpose, while the anodic coating insulates the circuit and preserves the structure. This simplifies physical design for electric circuits and saves space and wiring.

All the properties of anodizing contribute substantially to a product's life cycle and reduce energy demands.

Environmental Aspects of the Anodizing Process

Anodizing is a water-based process and uses no VOCs. There are no vehicle solvents, no carrier resins, and any pigmentation used in anodizing is created by extremely small amounts of metals or dye securely locked within the hard surface. No halogenated hydrocarbons or similar toxic organics are used in anodizing.

Similar neutralization reduces most anodizing chemicals to common dissolved minerals. Most anodizing is performed without generation of hazardous waste, and in many cases aluminum-rich anodizing wastes are environmentally valuable in removing pollutants and settling solids in domestic sewage treatment processes.

Safety of Anodizing process - Superior Metal Technologies

The unique anodized finish of Superior's comprehensive range of aluminum anodizing services is only one of the properties that make it a desirable finishing process. Anodizing is the perfect solution when health and environmental concerns arise.

When it comes to coatings, anodizing is a safe and environmentally friendly technology, as clean a process as is available today. Anodizing is an acceleration of a natural oxidation process. It does not produce harmful or dangerous by-products, and will not damage human health or the environment. Other benefits include:

An anodized finish will not break down or decompose

The finish is non-toxic

It is heat-resistant to 1,221° F, (the melting point of aluminum)

Anodizing uses simple water-based chemicals that can be treated easily and that release no harmful by-products

The liquid by-products are recycled and returned to the process

Solid by-products can be separated for other uses, such as:

Aluminum manufacturing

Baking powder

Cosmetics

Newsprint

Fertilizer

Anodizing's primary by-products are harmless – aluminum hydroxide and aluminum sulfate can be used as filters in the sewage treatment process of municipal sewage treatment plants.

Anodizing plants are safe, well ventilated, worker-friendly environments. Workers are well trained in the use of anodic materials and processes. In general, to ensure worker safety employees only need to wear a minimum of special protective clothing. In most cases, only a minimum of safety equipment is required.

3. METHODOLOGY AND PROBLEM IDENTIFICATION

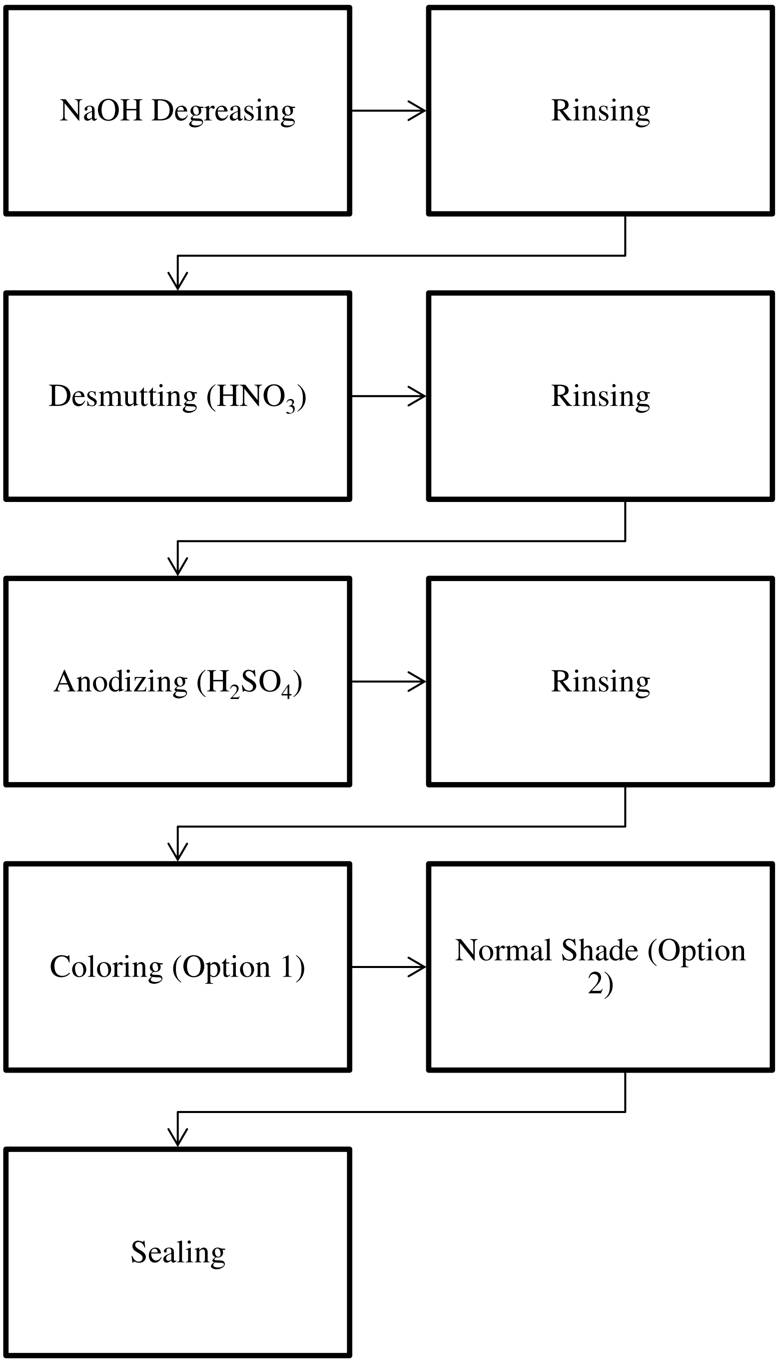
Through the literary review we can understand that anodizing process is environmental friendly and acceptable for today’s business needs and has energy saving potential and contributes to resource conservation. Hence it is acceptable process though it deals with many hazardous chemicals. It is organization’s ultimate responsibility to ensure the safety is assured in all the activities of the process. The engineering controls, administrative control and needed PPEs should be provided duly.

3.1 Anodizing shop in FTRTIL

This shop has a capacity of 7 batches per shift of 8 hours. Around 1700 varieties of components are being anodized in the shop. The anodizing cycle time is 45 minutes.

The shop uses Sodium Hydroxide (NaOH - Caustic soda), Sulpuric acid (H_2SO_4), Nitric Acid (NHO_3) and few proprietary chemicals.

Also, all the baths are with hot water which has potentials of harming humans. The water



after rinsing the materials to be anodized become hazardous as they are contaminated with grease and oils of materials.

3.2 Safety improvements requirements

As many of the activities in the anodizing process are hazardous and risk involved it will be always good to eliminate, mitigate the human interventions as much as possible. By going through various steps of the process we can identify the activities where the human interventions can be eliminated or mitigated.

3.3 Risk assessment

Being an ISO/EMS 14001 and OHSAS 18001, certified company, FTRTIL should properly identify hazards and their related risks before determining controls for such risks.

The following Severity Vs Likely hood table is being used to carry out such risk assessment.

		SEVERITY				
		Critical (5)	Very Serious (4)	Serious (3)	Marginal (2)	Negligible (1)
LIKELIHOOD	Frequent (5)	25 Operation not permissible	20 Operation not permissible	15 High priority	10 Review at appropriate time	5 Risk acceptable
	Moderate (4)	20 Operation not permissible	16 Operation not permissible	12 High priority	8 Review at appropriate time	4 Risk acceptable
	Occasional (3)	15 High priority	12 High priority	9 Review at appropriate time	6 Risk acceptable	3 Risk acceptable
	Remote (2)	10 Review at appropriate time	8 Review at appropriate time	6 Risk acceptable	4 Risk acceptable	2 Risk acceptable
	Unlikely (1)	5 Risk acceptable	4 Risk acceptable	3 Risk acceptable	2 Risk acceptable	1 Risk acceptable

After carrying out risk assessment, the action to be taken for the assessed risk score are given in the below table.

Colour	Score	Risks	Action
	16 - 25	High	Operation not Permissible Stop operation & review controls. If necessary abort experimentation.
	12 - 15	Warning	High priority remedial action Proceed with extreme caution with PI present at all times. Implement additional (secondary) controls immediately. Review within 7 days.
	8 -10	Medium	Take remedial action at appropriate time Proceed with care. Additional control is advised. Review shall be implemented within 30 days.
	1 - 6	Warning	Risk acceptable: Residual risk If possible, risk reduction should be further considered, particularly severity. There are no imminent dangers. Frequent review shall be in place especially changes in procedures, materials or environment.

4. RESULTS AND ANALYSIS

4.1 Risk Assessment: The hazard identification and risk assessment of Anodizing process was done using the Risk Assessment model – Severity Vs Likelihood matrix and the following results were found out.Through interview with the operators who are working in the shop the following observation were found.

1. Monitoring of rinsing or immersion time of components in the bath are stressful and difficult
2. The filtration of degreased bath water is not effective and the fumes in the bath is bit intolerable that leads to compulsory use of nose mask even for the visitors to the shop
3. The manual measurement of temperature of baths periodically is risky and lead to heat exposure to hands

Process	Activity	Risk	Score
Degreasing	Immersion of components in NaOH bath and monitoring time	Harmful Fumes and physical stress	Critical x Remote (10)
Rinsing	Immersion of component	Fumes	Very serious x Remote (8)
Desmutting	Immersion of components in HNO_3 bathand monitoring time	Harmful Fumes and physical stress	Critical x Remote (10)
Rinsing	Immersion of component	Fumes	Very serious x Remote (8)
Anodizing (H_2SO_4)	Immersion of components in H_2SO_4 bathand monitoring time	Harmful Fumes and physical stress	Critical x Remote (10)
Rinsing	Immersion of component	Fumes	Very serious x Remote (8)
Coloring	Immersion of component	Fumes	Very serious x Remote (8)
Sealing	Immersion of component	Fumes	Very serious x Remote (8)

4.2 Analysis

Referring the risk assessment table it is obvious that the process and activities are either **critical** or **very serious** related to severity and likelihood of occurrence is **remote.**

Though the chances are occurrence are remote, the process are critical and so the activities must be simplified and ease of operation should be assured.

A brainstorming has been done with all shift operators and supervisors and it was decided to mitigate the risk of manual intervention in monitoring and measurement timing and temperature.

5. RECOMMENDATION

After carrying out risk assessment, interviewing operators and brainstorming with all relevant members of anodizing, the following recommendation were given to Head – Manufacturing.

1. Implementation of better filtration system
2. Installation of digital temperature monitoring
3. Installation of timers for individual baths

In parallel the capex budget has been discussed with finance and being it is safety improvement program, it was duly approved by Management

CONCLUSION

After implementation of,

1. New effective scrubber system
2. Better filtration process
3. Digital temperature indictor system
4. Timer with buzzer system for individual bath

All activities in the anodizing shop have become **Acceptable Risk** zone with respect to **Risk Score.**

REFERENCE

The following books and other resources were referred for carrying this project.

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