Toxics Reduction Plan

Nitric Acid and Nitrates

Prepared by:

Brimac Anodising
542 Kipling Avenue
Toronto, ON
M8Z5E3

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Contents

Statement of Intent

Brimac anodizing is committed to continuing to reduce the environmental impact of its manufacturing operations. Management will continue to explore options to reduce the usage and creation of toxic substances while providing innovative solutions to our customers.

Brimac Anodizing has prepared this toxic substance reduction plan for nitric acid and nitrates at pH>6.0 to investigate options to reduce the usage of nitric acid and thus generation of nitrates at pH>6.0 while supplying customers with products that meet their needs.

As there are no technically or economically feasible options identified in the plan, there is no objective to reduce the usage of nitric acid.

As there are no technically or economically feasible options identified in the plan, there is no objective to reduce the creation of nitrates at pH>6.0.

General Information

Toxic Substance	Nitric Acid, nitrates
CAS#	7697-37-2, n/a
Number of full-time equivalent employees	30
NAICS	332810 Coating, engraving & heat treating activities
NPRI ID	632
UTM NAD83 coordinates (entrance)	619117, 4830040

Canadian Parent Company

Legal name	Brimac Anodizing Limited
Street address	542 Kipling Avenue Toronto, ON M8Z5E3
% owned by parent	100%
CCRA business number	100648740

Contact info

Owner and operator of facility	Brimac Anodizing Limited 542 Kipling Avenue Toronto, ON M8Z5E3

Highest ranking employee	Colin Brighton President (416) 255-4411 brimac@brimacanodizing.com
Person who coordinated preparation of plan	Colin Brighton President (416) 255-4411 brimac@brimacanodizing.com
Person who prepared plan	Wendy Nadan Nadan Consulting Ltd 151 Montgomery Blvd Orangeville ON L9W 5C1 519 940 4724 wendy@nadanconsulting.com
Public contact	Colin Brighton President (416) 255-4411 brimac@brimacanodizing.com
Technical contact	Wendy Nadan Nadan Consulting Ltd 151 Montgomery Blvd Orangeville ON L9W 5C1 519 940 4724 wendy@nadanconsulting.com

Planner

License number of planner	Wendy Nadan Nadan Consulting Ltd 151 Montgomery Blvd Orangeville ON L9W 5C1 519 940 4724 wendy@nadanconsulting.com TRSP 0092

1.0 Identification of Stages and Processes

Brimac Anodizing receives parts from customers, anodizes them and then returns them to the customer for further processing. Waste from the various baths is treated in a wastewater system before discharge to the sanitary sewer. The brightening rinse water is collected and sent off site for recycling. See Figure 1 for a process flow diagram of the facility and Figure 2 for a flow diagram of the anodizing process.

Aluminum alloys are anodized to increase corrosion resistance, to increase surface hardness, and to allow dyeing (coloring), improved lubrication, or improved adhesion and to enhance the appearance. The anodic layer is non-conductive.

When exposed to air at room temperature, or any other gas containing oxygen, pure aluminum self-passivates by forming a surface layer of amorphous aluminum oxide 2 to 3 nm thick, which provides very effective protection against corrosion. Aluminum alloys typically form a thicker oxide layer, 5-15 nm thick, but tend to be more susceptible to corrosion. Aluminum alloy parts are anodized to greatly increase the thickness of this layer for corrosion resistance and provide a decorative finish.

Although anodizing produces a very regular and uniform coating, microscopic fissures in the coating can lead to corrosion. Further, the coating is susceptible to chemical dissolution in the presence of high and low pH chemistry, which results in stripping the coating and corrosion of the substrate. To combat this, various techniques have been developed either to reduce the number of fissures or to insert more chemically stable compounds into the oxide, or both.

Anodized coatings have a much lower thermal conductivity and coefficient of linear expansion than aluminum. As a result, the coating will crack from thermal stress if exposed to temperatures above 80 °C. The coating can crack, but it will not peel. The melting point of aluminum oxide is 2050 C, much higher than pure aluminum's 658 C. (This and the non-conductivity of aluminum oxide can make welding more difficult.) In typical commercial aluminum anodization processes, the aluminum oxide is grown down into the surface and out from the surface by equal amounts. So anodizing will increase the part dimensions on each surface by half the oxide thickness. For example a coating that is (2 µm) thick, will increase the part dimensions by (1 µm) per surface. If the part is anodized on all sides, then all linear dimensions will increase by the oxide thickness. Anodized aluminum surfaces are harder than aluminum but have low to moderate wear resistance, although this can be improved with thickness and sealing.

Preceding the anodization process, wrought alloys are cleaned in either a hot soak cleaner and in a hot acid cleaner and may be etched in sodium hydroxide (normally with added sodium gluconate) or brightened in a mix of acids. Nitric acid in the brightening solution is used to chemically polish the aluminum alloys.

The anodized aluminum layer is grown by passing a direct current through an electrolytic solution, with the aluminum object serving as the anode (the positive electrode). The current releases hydrogen at the cathode (the negative electrode) and oxygen at the surface of the aluminum anode, converting the aluminum surface to aluminum oxide.

Nitric acid is received in bulk and pumped into a storage tank. It is pumped directly from the storage tank to the brightening tank as needed.

Nitric acid is found in the acid mixture used in the sobrite bath. This is a passive dip process. The tank is never emptied. The first rinse tank is isolated from the second and third rinse tanks as it accumulates the greatest concentration from drag out. Once the specific gravity of the first rinse tank reaches 1.32-1.35, the rinse water is collected in a storage tank and sent back to the supplier for recycling and reuse as a fertiliser.

As the brightening tank is maintained close to boiling at 102-104C, there is some loss from evaporation. There is also consumption of the nitric acid that generates NOx. The vapour is captured and routed through a wet scrubber on the roof that uses caustic soda to neutralize acid gases to nitrates. The water from the scrubber is sent to the wastewater treatment process which then discharges to municipal sewer.

Nitrates at pH>6.0 are not used in the facility but are created by the neutralisation of nitric acid/NOx in the bright dip scrubber. No nitrates are contained in product.

Losses of nitric acid from the brightening tank are either via drag out into the rinse tank or by consumption during the brightening process that generates NOx. Dragout has been minimized by holding parts over the brightening tank for 10 seconds before submerging in the first rinse tank.

Samples from the brightening tank (sobrite tank) are analyzed daily to ensure that the acid and aluminum content remains within specification. The tank is adjusted to maintain optimum anodizing and brightening quality.

Chemical brightening is used to create a bright finish on the alloy similar in appearance to chrome. The same effect can be achieved by mechanical polishing however mechanical polishing is significantly more expensive. The colour and finish on the metal is specified by the customer.

2.0 Material Accounting

See Figure 3 for the brightening process flow chart.

The quantity of nitric acid input into the process is calculated from annual purchases provided by suppliers. This is the best available method for quantifying inputs and the data quality is considered high.

The quantity of nitric acid contained in rinse solution transferred offsite for recycling is assumed based on sampling results. The specific gravity of the rinse solution is tested daily and recorded.

A mass balance is used to calculate consumption of nitric acid in the brightening tank during the chemical polishing. The major decomposition product is NOX which is emitted from the surface of the tank. The nitric acid is thus transformed to NOx and then nitrate before being discharged to sewer.

3.0 Cost of Using Nitric Acid

Raw material cost	$6,819
Wastewater treatment	$25,827
Cost to heat phosbrite tank	$5,880
Scrubber chemicals	$2,709
Revenue from recycling	-$341.50
Total	**$40,893.50**

4.0 Identification of Options to Reduce the Use of Nitric Acid

The following options were identified to reduce the usage of nitric acid:

Category	Description
Material substitution	Option 1: Use an alternate material in the brite dip bath. This option is estimated to result in reduction in use of nitric acid of 100% or 12,113kg and quantity transformed of 11,118kg or 100%. It will also reduce creation of nitrates by 100%.
Product Design	Brimac does not own the design of the product. Material for anodizing is supplied by the customer and returned to the customer. Hence an option is not available in this category.
Process modification	Option 2: Lower the temperature of the brite dip bath to reduce evaporation. Reduction by 10C is estimated to result in reduction in usage of 5% or and the same quantity transformed. Option 3: Use mechanical polishing instead of chemical polishing. This option is estimated to result in reduction in use of nitric acid of 100% or 12,113kg and quantity transformed of 11,118kg or 100%. It will also reduce creation of nitrates by 100%. Option 4: Increase the holdover time to reduce dragout. This option is estimated to result in reduction in use of 10% or 1,211kg and quantity of off site transfer by 10% or 41kg/year. It will have no effect on the quantity

	transformed to nitrates or the quantity of nitrates created.
Spill and leak prevention	Option 5: Inspection of piping and tanks. A program to inspect the tanks and piping twice annually will detect leaks and reduce losses. It is estimated that reduction in use of nitric acid by 1% can be achieved by implementing this option. There will be no change in quantity transformed to nitrates or the quantity of nitrates created.
Reuse or recycling	Option 4: Increase the holdover time to reduce dragout. This option is estimated to result in reduction in use of 10% or 1,211kg and quantity of off site transfer by 10% or 41kg/year. It will have no effect on the quantity transformed to nitrates or the quantity of nitrates created. Option 6: The brite dip rinse water is contained and sent off site for recycling. The nitrates and phosphates are used for fertilizer. Recycle the rinse water in house instead of shipping off site. Option 7: The delivery truck is connected by hose to the bulk tank. The liquid left in the hose currently drains into the wastewater treatment system. The material can be collected in a bucket and reused in a process tank. This option is estimated to result in a very small reduction in use that would not be measureable.
Inventory management	Nitric acid is received in bulk. It is transported by tanker truck and hence is ordered in a fixed quantity. Reordering is triggered when the tanks are approximately 15% full. As the inventory is continually turned, there is no waste from expired product and hence there is no option in this category.
Training	Option 8: see option 5

5.0 Assessment of Technical Feasibility

Each of the options identified above were screened for technical feasibility using the following criteria:

- Availability and reliability of technology
- Impacts on quality, reliability, functionality
- Impact on production rate
- Compatibility with customer requirements
- Availability of employee training
- Compatibility with existing processes
- Space within facility
- Time required for change

Option	Assessment of Feasibility	Feasible
Option 1: Use alternative material in the dip bath	There is no other material that will achieve the same finish as the brite dip bath. Since the customer specifies the finish required, it is not technically feasible to achieve the required result by a different method.	No
Option 2: Lower bath temperature	The bath temperature is maintained in the range of 102-104C. Lowering the temperature and increasing the dwell time results in a duller part. At a temperature below 88C there is effectively no brightening. Customers require a bright finish and will not accept less brightness.	No
Option 3: Mechanical polishing	Mechanical polishing will also produce a shiny finish however it creates particulate PM2.5 which is also a toxic substance. Replacing one toxic substance with another provides no net benefit.	No
Option 4: Increase holdover time	Some nitric acid is carried over from the dip tank to the rinse tanks. The holdover time has already been optmised to 10 seconds to increase the reuse of the bath and reduce the quantity lost. The aluminum cannot be allowed to dry before rinsing however as this will cause spots on the surface. 10 seconds has already been established as the optimum holdover time.	No
Option 5: Tank and pipe inspection	This option has already been implemented. There is an item on the maintenance checksheet to check for leaks in the system.	No
Option 6: On site rinse water recycling	Recycling rinse water for use as fertilizer requires significant additional space to process the liquid. There is insufficient space in the facility to accommodate the equipment required.	No
Option 7: Collect contents in delivery hose	This option is simple and feasible however it is unmeasureable.	No

6.0 Economic Feasibility

There are no technically feasible options and hence no economic feasibility is required.

7.0 Implementation of Options

Due to customer requirements, there are no technically feasible options available to reduce the use of nitric acid and hence the creation of nitrate at pH>6.0.

8.0 Planner Recommendations

As the planner has worked with the facility throughout the development of the plan, information provided by the facility has been clarified and revised based on the options identified. Hence there are no recommendations to improve the plan.

9.0 Certification

As of December 12, 2014, I, Colin Brighton, certify that I have read the toxic substance reduction plan for nitric acid and nitrates at pH>6.0 and am familiar with its contents, and to my knowledge the plan is factually accurate and complies with the Toxics Reduction Act, 2009 and Ontario Regulation 455/09 (General) made under that Act.

______________________________ ____________________

Colin Brighton, President Date

As of December 3, 2014, I, Wendy Nadan certify that I am familiar with the processes at Brimac Anodizing that use nitric acid and create nitrates at pH>6.0, that I agree with the estimates referred to in subparagraphs 7 iii, iv and v of subsection 4 (1) of the Toxics Reduction Act, 2009 that are set out in the plan dated November 30, 2012 and that the plan complies with that Act and Ontario Regulation 455/09 (General) made under that Act.

December 6, 2014

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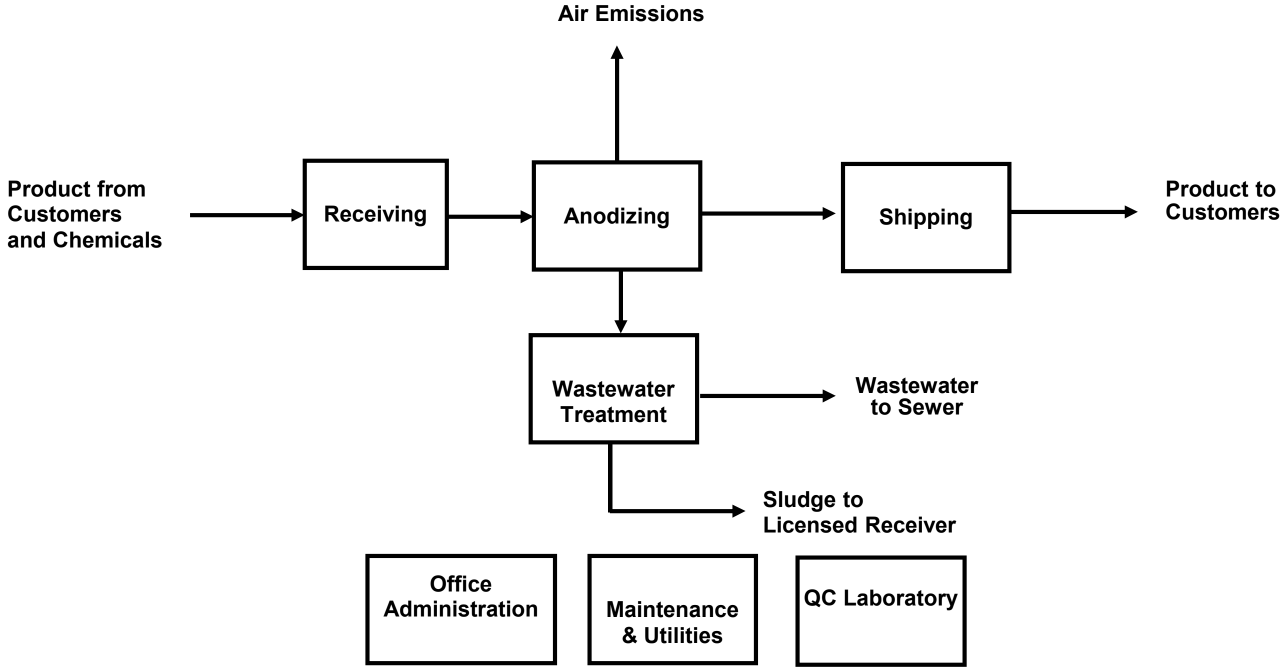
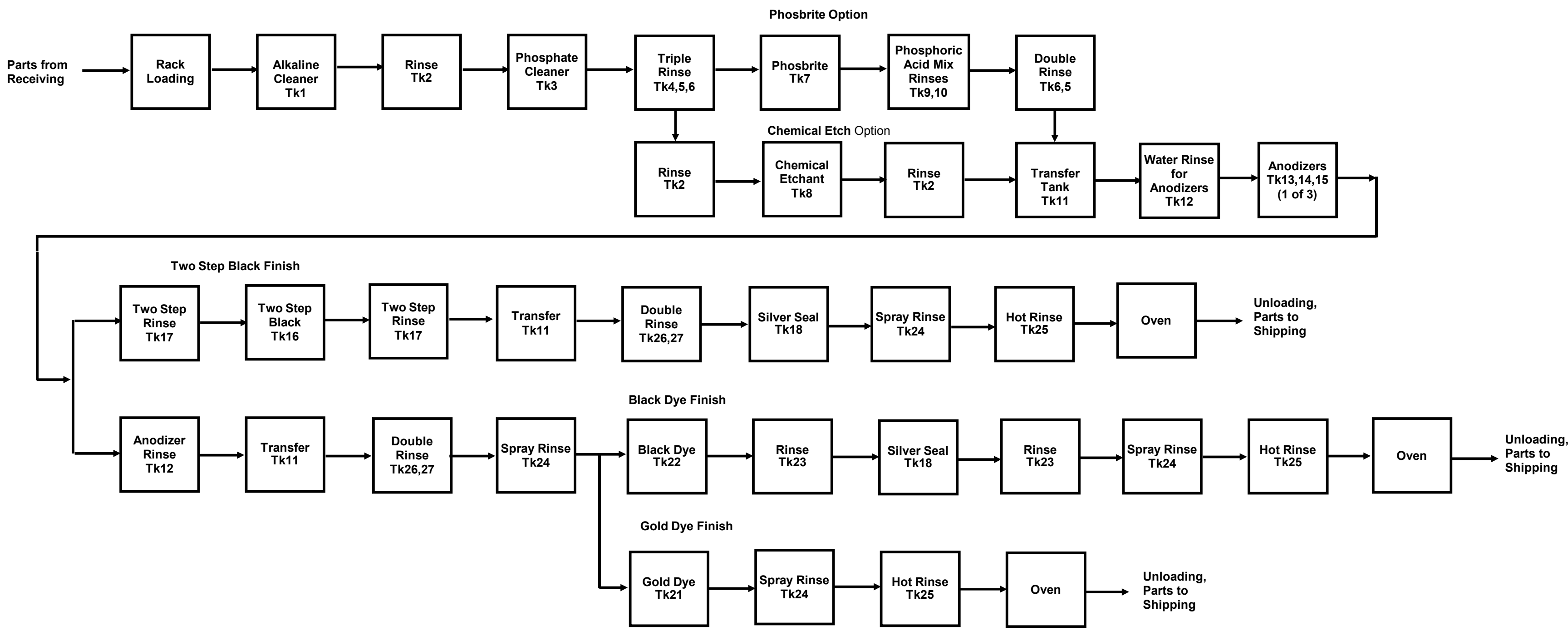
Wendy Nadan, Toxic Substance Reduction Planner Date

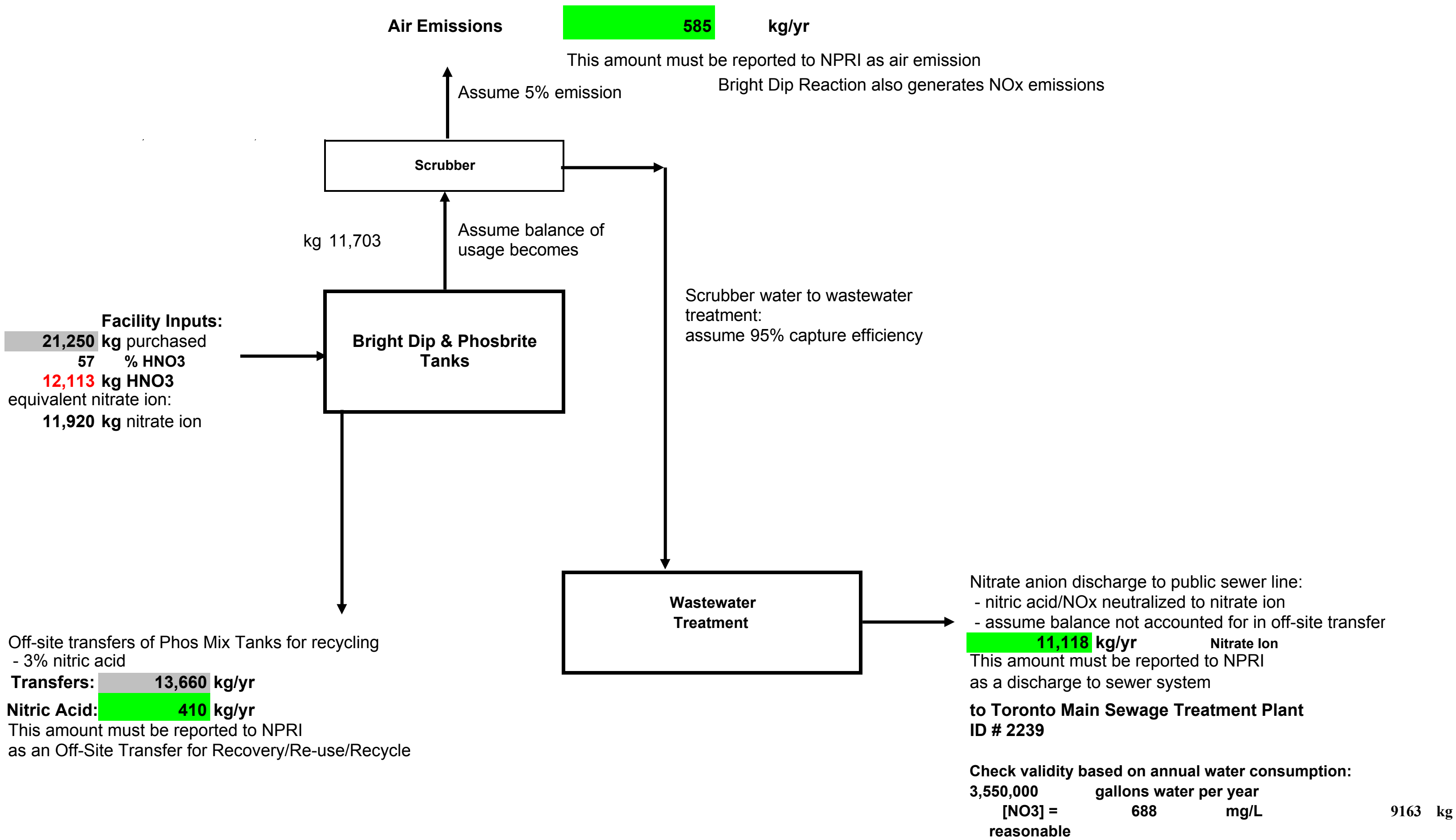
Overall Process Flow Diagram



Anodizing Process Flow Diagram



Nitric Acid and Nitrate Ion



Material Balance

Nitric Acid	Purchased	Created	Contained in Product	Shipped Off-Site	On-site Releases	Destroyed	Transformed	Discrepancy
	12,113	0	0	410	585	11,118	11,118	0

Comment: Material balance is perfect, since amount destoyed is obtained by difference between purchased and transfers/releases