Proper Phosphorus Removal for Wastewater in Anodizing Processes

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As a nutrient, phosphorus is part of the growth cycle of nature. As with everything, however, too much of something can have a negative impact. When phosphorus is found in excessive amounts in waterways, algae and bacteria can grow in abundance, which can have the following detrimental effects on the environment:

- Algae blooms that deplete oxygen to the point that higher lifeforms such as fish cannot survive.
- Sunlight is prevented from reaching the floor of the waterway, which kills off plant life in the area.
- Cyanotoxins from bacteria growth spurred by excessive phosphorus can turn the water toxic and unsuitable for human consumption.

It falls to manufacturers and applicators to ensure that their wastewater effluent does not harm the environment they discharge to. In the finishing and coating industry, this can often be an issue for the facility. The purpose of this paper is to explain the need for phosphorus removal with the focus on laden wastewater and show a real-life example of how this was accomplished in wastewater generated from an anodizing process.

HOW APPLICATORS GENERATE PHOSPHORUS DISCHARGE

The anodizing process is an electrochemical process that converts the surface of the metal part to an anodic oxide finish that is durable, corrosion-resistant, and decorative. While ideally suited for aluminum, other non-ferrous metals such as titanium or magnesium can also be anodized. Anodizing increases the wear and corrosion resistance while providing a finish that can be decorative or can be idea for additional processes steps such as painting or gluing. Anodized parts can be found in aerospace, automobile, and marine applications, to name a few.

Anodizing follows set steps to ensure the parts meet the quality desired after completion of the process. The steps are:

- Cleaning: removes soils and prepares the parts for anodize and post-treatment. Removes protective oils, polishing compounds, surface oxides, greases, fingerprints, dust, chips, and other solids. It can be an alkaline cleaner, acid cleaner, or solvent.
- Pretreatment through etching or brightening etching can be done with alkaline or acid products. It produces a uniform finish that is matte or satin. The bright dip is a nitric/phosphoric acid blend. It produces a mirror finish.
- Deoxidation/DE smutting: removes smut left by etching or cleaning. Deoxidizers will remove smut, but DE smutters will not deoxidize.
- Anodization: the electrochemical oxidation of the metal to produce a stable oxide on the surface of the part. Parts are placed in an electrolyte solution and act as the anode. An electric current is passed between the “anode” and a cathode through the electrolytic solution, thus anodizing the part.
- Post-treatment: coloring, dyeing, sealing. Electrolytic coloring deposits metal into the oxide layer to color. Dyeing is a soak process that allows the dye to be absorbed into the pores. Sealing converts the oxide layer to boehmite and is more resistant to atmospheric attack.

Each step of the anodizing process is followed by multiple rinsing tanks to ensure there is no contamination from one process tank to the next. Any rinse that follows a step that has phosphate in it contributes to the phosphate loading in wastewater. Typical anodizing wastewater streams can have to 4000mg/L of total phosphorus. When looking at phosphate in wastewater, there are several kinds: dissolved, inorganic, organically bound, organic, orthophosphates, and condensed phosphate (such as pyro-, meta-, and other polyphosphates).

STEPS TO REDUCE TOTAL PHOSPHORUS

Total phosphorus (TP) is what is usually seen on discharge permits and encapsulates all forms of phosphorus in the waste stream. While bacteria are a viable option for removing phosphorus from wastewater, anodizing manufacturers and applicators rarely have the space for these systems on their shop floor, or the personnel to run them. Thus, physical/chemical means are the best way to remove phosphorus from wastewater. Physical/chemical wastewater treatment is when physical means of removing contaminants — such as filtration — is combined with chemical means such as hydroxide precipitation to ensure that the wastewater is sufficiently clean for discharge. This process can be broken down into three steps:

- Coagulation: the clumping together of very fine particles into larger particles called floc, which are caused by the use of chemicals. The chemicals neutralize the electrical charges of the fine particles, allowing them to come closer to form larger clumps. (Industrial Waste Treatment, Volume 1, 3rd edition)
- Flocculation: the gathering of fine particles after coagulation to form larger particles by a process of gentle mixing. This clumping together makes it easier to separate the solids formed in the water by settling, skimming, draining, or filtration. (Industrial Waste Treatment, Volume 1, 3rd edition)
- Liquid/Solid Separation (Dewatering): to remove or separate a portion of the water present from the solid, with or without chemical conditioning, for the purpose of handling or disposing of the solids. (Operation of Wastewater Treatment Plants, Volume 2, 7th edition)

For phosphorus removal to occur in this physical/chemical treatment process, the phosphorus particles must become destabilized and coagulated for removal. In this study, some of the most common coagulants used for phosphorus removal are compared on a side-by-side basis to help show which products may work best in an anodizing facility. Calcium chloride, poly aluminum chloride, lanthanum chloride, AquaPure Cal 50 Plus and AquaPure Cal 76 are each bench tested at the same dosing and same pH. The AquaPure products from Hubbard-Hall are specialty coagulants designed for phosphorus removal, check out our case study to see what the tests results are.

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