# Protecting Your Stainless Steel:
## Passivation for Brewery Equipment

*your partner in food safety*

By Dana Johnson, Technical Director, Craft Brewing, Birko
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The explosion of new craft breweries in the United States in recent years coupled with imported stainless steel of inferior quality, has created a much greater need to make sure new brewing equipment is properly passivated prior to being put into use. What does passivation mean? How does one passivate brewing equipment? This article will detail the chemicals and procedures brewers should use to passivate brewing equipment and ensure their beers will taste like they should – fresh, flavorful and free of metallic or any other off-flavors.

### What Is Passivation?

Passivation in brewing is defined as the process of chemically treating stainless steel with an invisible, protective layer or coating so the metal will not be as susceptible to corrosion and pitting caused by cleaning chemicals (acids, caustics, sanitizers), carbon dioxide ($CO_2$) and beer. Stainless steel by definition is a very hard and durable metal, but it is not as indestructible as most people may think. Certain chemicals, especially chlorides (e.g. table salt, NaCl), are known to be very hard on stainless steel and can cause pitting if the metal is not passivated to avoid corrosion. Even beer, with its lower pH and $CO_2$, can cause pitting to stainless steel over time.

### What Is Descaling and Pickling?

Although often confused with passivation, pickling and descaling (oxide removal) must first be performed to clean down to bare metal for the subsequent passivation steps to be successful. Although used synonymously with passivation, descaling and pickling remove the oxides from the metal to enable effective passivation. Pickling of metal is done to remove iron and oxides from stainless steel. If the metal is not cleaned first, it will not be passivated. Descaling and pickling are done with very strong acids including hydrochloric acid (HCl), nitric acid ($HNO_3$), hydrofluoric acid (HF) or sulfuric acid ($H_2SO_4$).

### Traditional Passivation

The two most common chemicals traditionally used for stainless steel passivation for breweries are citric acid and nitric acid. Citric acid is a mild, organic acid and is very good at chelating iron, but does not by itself leave behind a protective coating to keep the metal from being passive (impervious to chemical attack). Nitric acid used in high concentration (about 20% active or more) is the most well-known method of passivation and, when followed by a 24-hour air dry, creates an invisible chromium oxide ($Cr_20_3$) layer to protect the metal.

A problem with this method is that it is not permanent and is rarely (if ever) repeated in the brewery due to the hazards of using an extremely dangerous concentration of nitric acid. This presents a problem for brewers who do not regularly deep clean and re-passivate the metal on a regular basis – at least twice a year. So, what is a brewer to do to safely keep the metal not only clean, but in pristine, like-new condition?

## Newer, Safer Passivation

There are ways to keep the metal in good condition, flavor-neutral and shiny without having to resort to extremely hazardous chemicals and concentrations. Acid cleaning and drying to form the $Cr_2O_3$ layer no longer work as well as they once did and create a condition called “flash rusting” (iron deposit) especially around welds. Using a nitric acid blend immediately followed by alkaline noncaustic cleaner method, first detailed in *The New Brewer* (Noncaustic Cleaning In The Brewery, March/April, 1996), is still widely used and is one of the best ways to not only keep the metal clean, but passivated at the same time. Many breweries that adopted this cleaning regime over 20 years ago still use it, regardless of whether they’ve outgrown their original equipment or not.

## Conversion Coating Passivation

Following the acid with noncaustic alkaline cleaner may seem at first to be completely foreign to brewers who consistently use the caustic-rinse, acid-rinse method of cleaning their tanks. While the tried-and-true method works well to remove protein soil, it tends to be less effective on beerstone and does not properly passivate the metal. Over time, soils can build up, and the metal can develop microbial induced corrosion (MIC). If left unchecked, these deposits can pit the metal. So, how should you treat metal to keep it in excellent condition?

Here is the procedure for existing equipment (brewhouse and fermentation vessels):

1. Rinse excess soil if necessary.
2. Put in 1-2 ounces per gallon of water of nitric/phosphoric acid blend. Make sure pH is 2 or lower. Recirculate through sprayballs for a minimum of 15 minutes at a maximum temperature of 140° F. [Do not exceed 140° F (60° C)] to keep the nitric acid in the solution, not in the air.
3. Drain the acid solution but **do not rinse!**
4. Depending on soil conditions, put in 1-2 ounces per gallon of noncaustic alkaline cleaner that contains either hydrogen peroxide or sodium percarbonate. Recirculate through sprayballs and/or heat exchanger at 120-140° F (50-60° C) for 15-30 minutes.
5. Drain solution. Immediately follow with step 6.
6. Rinse equipment, preferably with the same temperature of hot potable water. Check the pH of rinse water and vessel wall if possible. When pH is neutral, the passivation step is complete.

## What about new equipment?

Assuming the metal has already been passivated at the factory, new stainless steel should be in fairly decent shape when it arrives at your brewery. There can however be residual machine oil, road grime, dust, dirt and debris on new metal. In this case, an alkaline hot

caustic cleaning is recommended to remove machine oil and debris. If any surface rust is observed, a citric acid rinse does a nice job of removing surface rust. Follow with the six steps mentioned above.

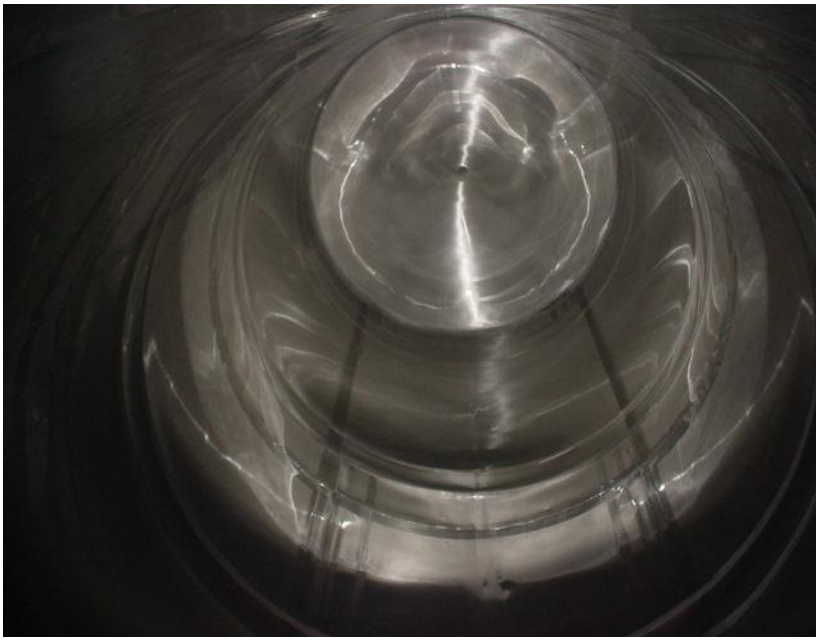
Here is the procedure to passivate new stainless steel:

1. To remove any machine oil, road grime, etc., CIP with a 2 oz. heavy-duty, non-chlorinated liqud built caustic CIP Cleaner per gallon of hot water (140-180° F) for 15-30 minutes. Drain and then rinse well immediately.
2. If there is any surface rust, CIP using a 2 oz. citric acid per gallon of 120-130° F water CIP for 15-30 minutes, then rinse well.
3. Immediately after rinsing the citric acid, CIP with a phosphoric/nitric acid blend followed by and oxygenated noncaustic cleaner using the conversion coating passivation steps.

**Conversion Coating Passivation Steps:**

1. Rinse with ambient to warm water.
2. CIP with 2 oz. of nitric/phosphoric acid blend per gallon of 120-130°F water for 15-30 minutes.
3. Drain but do not rinse.
4. CIP with 2 oz. of phosphated, silicated and oxygenated noncaustic alkaline cleaner per gallon of 120-140°F water for 15-30 minutes.
5. Rinse well.

When finished, the metal should look like this:



Remember, the aforementioned acid drained but not rinsed and immediately followed by noncaustic, oxygenated, alkaline cleaner method of passivation is known to metallurgists as a phosphate/silicate conversion coating, and should not be confused with the traditional high nitric acid method, which is drained but not rinsed and then followed by a 24-hour air dry to form a chromium oxide layer on the metal.

### Cleaning with caustic and hydrogen peroxide to maintain passivation:

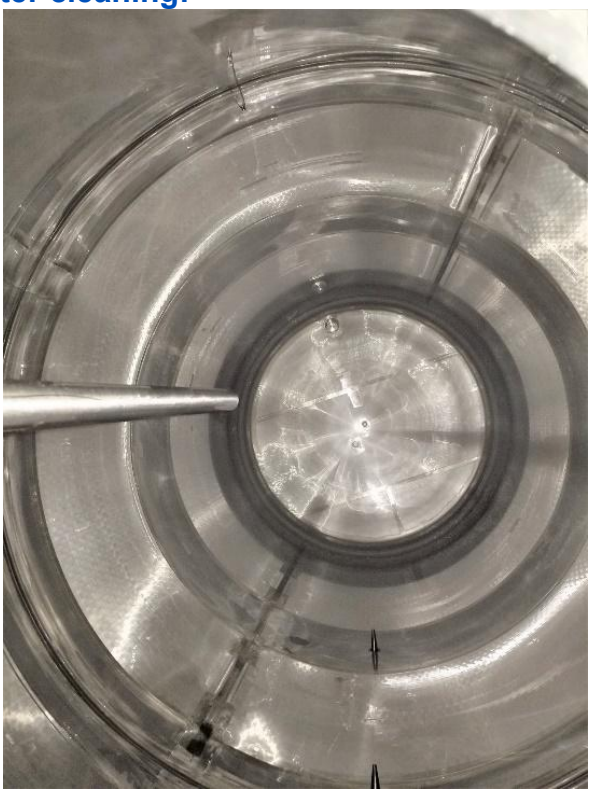
As I mentioned in my *The New Brewer* article last year, (Improving Brewhouse CIP, July/August, 2017) cleaning with caustic and hydrogen peroxide and following with an acid finish is an excellent way to not only keep the metal clean and shiny, but it also offers some passivation properties as well.

Without completely going into the whole procedure for that again, here is what the fermentation vessel looks like after cleaning with caustic and hydrogen peroxide and followed with an acid rinse:

### Before Cleaning:

### After Cleaning:

**Here is a fermenter after cleaning:**



## Conclusion:

Every brewer knows that keeping brewing equipment cleaned and sanitized is the key to making the beer taste its best batch after batch. Passivation has not been well understood by brewers but is also key to keeping the beer tasting fresh and flavorful. Consult your chemical provider for their recommendations to keep your equipment not only cleaned but passivated, too.

**About the Author:**

Dana Johnson consults with craft breweries, wineries, and distilleries on food safety and sanitation practices. He has more than 20 years of experience serving Birko's brew customers and is known in the industry as one of the leading voices on sanitation.

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