

TECH TIPS

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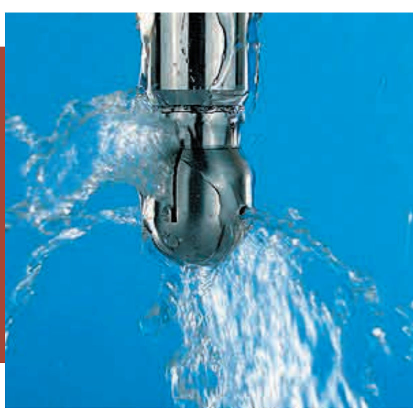
Stubborn Soils

For food safety and optimum product quality, soils on food processing equipment need to be removed. Tech Tips #13 addressed *Common Soils Encountered in Food Processing*. In that issue, we discussed the normal soils found in food processing plants plus the different types of detergents used for cleaning and removing those soils. In this issue of Tech Tips, we're furthering that discussion addressing the more stubborn, tenacious and somewhat unusual soils encountered in food processing environments. We'll explain why these particular soils occur, then provide a general recommendation on how to remove the soil and clean the surface.

A couple of initial points: First, identifying the soil or film is sometimes half the problem. We'll provide pictures and a general description of the soil, but a laboratory confirmatory analysis may be required. Second, since conditions and equipment will vary, for the specific cleaning regimen, consult your JohnsonDiversey Account Manager.



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I. Calcium Stearate (aka Soap Scum)

What is it? Calcium stearate will appear as a gray film, inside tanks, lines and valve clusters that are washed by CIP (Clean in Place). This soil is often first noticed in low flow areas around valve seats or elbows. Calcium stearate will cause water to bead on the surface. When the film becomes thick enough, calcium stearate can be scraped off and it appears soft and waxy. Calcium stearate originates from fat. Fats are triglycerides and a triglyceride contains three fatty acid chains. The types of fatty chains vary in the triglyceride, (for example, palmitic, oleic and stearic acid). Alkali and caustic will break a triglyceride apart freeing the fatty acids. (This is the process of making soap.) Stearic acid is one the highest melting and least soluble of all fatty acids. In an alkaline environment, stearic acid is neutralized, reacts with free calcium and calcium stearate is produced. Calcium stearate has extremely low water solubility, so the solid (soap scum) forms. If the CIP re-use wash tank is excessively soiled, as seen below, calcium stearate can easily form. Excessively soiled CIP wash tanks can lead to the formation of calcium stearate.

Excessively soiled CIP wash tanks can lead to the formation of calcium stearate.

What to do about it?
First, the obvious. If utilizing a re-use CIP system, insure the wash tank(s) are regularly dumped and cleaned. Also, insure that wash tank skimming (removal of fat and debris from the surface) is functioning properly. Calcium stearate tends to occur more in hard water areas. Therefore, make certain that the CIP detergent has sufficient chelation capacity for the water and soil conditions. Once calcium stearate has formed in the system it needs to be removed with a special wash of a built caustic (NaOH) and **Everest Three**. **Everest Three** is an additive that has the capacity to sequester the calcium from the calcium stearate matrix. A couple of application notes here:

1) Do not use a chlorinated alkaline detergent with **Everest Three**. It needs to be caustic based.
2) Because the calcium stearate forms a very tenacious film, repetitive washes may be necessary.
3) Hand scrubbing may be required in low flow areas.

II. Manganese Dioxide Stains

What is it? Manganese (Mn) is a gray mineral with a reddish tone that is present in low concentrations (less than 0.5 PPM) in many water supplies. In basic solutions, manganese is oxidized to manganese dioxide (MnO_2), a dark brown precipitant. Like iron, this process is accelerated when oxidizers such as chlorine, iodine, or peroxides are present in the solution. In the initial stages, manganese stains may not be that noticeable, the equipment may just appear dull. If allowed to build, or if there has been sudden surge of Mn in the water supply, it can become a brownish/black glaze on equipment surfaces. It is for this reason that manganese staining is so objectionable. A manganese dioxide film can turn stainless steel almost black.

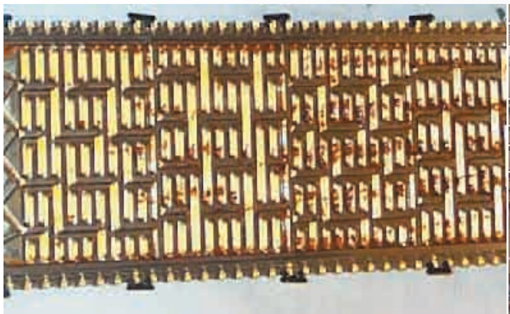
A manganese dioxide film can turn stainless steel almost black.

What to do about it? First, does the water supply contain manganese? If it does, periodic washing with a blended acid such as **Nonstick** is usually sufficient. If the MnO_2 has developed into dark or black films; it will be necessary to perform a caustic wash with a strong chelant additive such as **Everest Three.**

III. Tea/Pulp Deposits in HTST (High Temperature Short Time) Pasteurizers

What is it? Beverages that are heat treated and contain pulp (i.e. orange juice) or particulates, like some teas can leave residues such as evident below. These are difficult to remove from HTST plates during CIP. These residues interfere with heat transfer, product flow and can create quality issues.

What to do about it? Pulp and other deposits can be removed with an oxidizer. Because of temperature, it isn't practical to utilize sodium hypochlorite (NaOCl); however, hydrogen peroxide (H_2O_2) is an option. At high temperature and pH, H_2O_2 is an aggressive oxidizer that can remove pulp and other particulate debris. **FP Destainer** is a powdered oxygen bleach that releases H_2O_2 in solution. When added to an HTST caustic wash, **FP Destainer** can remove pulp and other particulates.



Sample of a fouled HTST plate

JohnsonDiversey laboratory CIP system

Sample of a pulp HTST plate

IV. Silicate Films

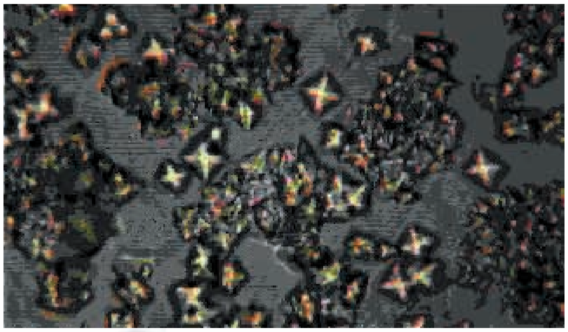
What is it? Silica occurs widely in nature as sand or quartz. Silica is also found in some water supplies. In order to provide corrosion protection to soft metals such as aluminum, some detergents are formulated with sodium metasilicate, another form of silica. Unfortunately, silica is very insoluble and can form white to gray films on equipment.

What to do about it? First, whenever using a silicated detergent make sure it is rinsed well from the surfaces. Never allow detergent solutions to dry on the surface. Avoid acidification of detergent residues on surfaces. A silica film is usually detected by the process of elimination. Normal acids just don't shine up the equipment. Silica has only been found to be soluble in a hydrofluoric acid based product such as **Film and Scale Remover**. A note of special caution here; **Film and Scale Remover** is a very aggressive product. Proper PPE (Personal Protective Equipment) such as rubber gloves, goggles, face shield and protective clothing are a must! Consult the MSDS for specific recommendations.

Against a normal stainless panel is a coupon with a silica film.

V. Oxalate Complexes

What is it? Oxalate complexes develop during the processing of slightly acidic foods and beverages and are generally light gray to brown in color. When vegetables, such as celery, spinach or beets are processed, they can produce calcium oxalate - CaC_2O_4. Calcium oxalate can combine with other materials and depending on the process, produce a deposit such as "celery stone". In brewing, calcium oxalate, in combination with insoluble proteins and other materials, produces "beerstone". If not properly cleaned, these stones will continue to build in tanks, lines and processing equipment eventually leading to microbiological and other quality issues.



Beerstone: clusters and single crystals of calcium oxalate embedded in other material: Magnification 50X

What to do about it? An ounce of prevention is worth a pound of cure here. One of the best methods of controlling beerstone and other oxalate films is to control the calcium in the alkaline or caustic wash. If free calcium isn't available, it will not complex with the oxalate. A built caustic detergent with a sufficient amount of chelant is the 'ounce of prevention'. In the finishing areas of brewing, another preventive measure is the use of an acid detergent such as **Divosheen Advantage Plus**. Once beerstone or other oxalate films develop, it'll be necessary to perform a caustic wash with a strong chelant additive such as **Complex**.

VI. Stains on Stainless Steel

What is it? When we say stains on stainless steel, we are not talking about the occasional rust spot than can be removed with an acid. We're talking about a stain that cannot be removed with concentrated nitric acid (HNO_3). We are talking about a stain so set that unless the stainless steel surface is gouged with a knife, it cannot be scraped off. These stains will display various colors from yellow to jet black. This staining tends to occur in high temperature heat processing equipment like evaporators, batch pasteurizers, HTST units and tubular heaters.

So, what is the make-up of these stains? Our laboratory has had these stains analyzed via surface chemistry and this may surprise you. First, they are wafer thin: 600–800 Angstroms; that is 0.000006 -0.000008 cm! Second, the analysis showed a multi-component film composed of carbon, nitrogen, calcium chloride and phosphorus (C, N, Ca, Cl and P).

Stained underside of an evaporator lid

How do these stains form?
Essentially what happens is incomplete cleaning has left small amounts of minerals behind on the stainless steel surface. Over time, these mineral layers selectively build leaving the most insoluble portions. Remember, that these stains have various colors. The color is due to the thickness of the film. When the stain is very thin, it is yellow. As it becomes thicker, it will change from gold to red to blue. Finally, when it is thick enough and can no longer reflect light; it is black.

What to do about it? Recall that when we discussed oxalate removal, we indicated that an ounce of prevention is worth a pound of cure? In this case, an ounce of prevention is worth hundred pounds of cure! The "ounce of prevention" is to have a complete clean of the stainless surface and not allow minute films to form. We tend to see these stains on stainless where cleaning is preformed with straight caustic (NaOH). Utilizing a properly built detergent is the fist step, or the ounce of prevention, in avoiding these stains.

Now, the hundred pounds of cure. The method for removing the stain has to be strong enough to remove the stain but not damage the stainless steel. The most effective method found has been the Alkaline Permanganate Destaining Procedure. In this procedure, potassium permanganate ($KMnO_4$) oxidizes and ulcerates the permanent film bonded to the surface. A word caution, this procedure is not easy and all PPE need to be utilized. A hot, 180 ºF (82 ºC) solution of caustic and potassium permanganate is circulate for at least an hour over the discolored stainless steel surfaces. (To destain, the solution does need to be that temperature.) The surfaces are then washed with an acid. This procedure works, but it's just much wiser to invest in the ounce of prevention - use a properly built caustic.

We've said this before in Tech Tips, the most important requirement in a sanitation program is knowledge. Soils form on food processing equipment for specific reasons. Understanding the reasons can not only aid in proper removal of the soils, but prevent them from forming. This ultimately improves food safety.

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