

Proper Stainless Steel Passivation Techniques (Critical Applications)

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(July 15th, 2014)

The Stainless Steel is resistant to corrosion due to very thick film of Chromium Hydroxide, it is only few molecules thick and it is not visible for human eye. This Chromium Hydroxide layer is passive to surrounding atmosphere. Normally, passivation of stainless steel is automatically done process. The film of Chromium hydroxide can be recovered by sufficient amount of oxygen and during tank cleaning with DI water wash. But, this process needs a lot of time. However, thickness of passive layer can be reduced by carriage of highly corrosive and aggressive acids, like Sulphuric acid, Phosphoric acid etc. If the vessel is engaged in continues trade with this kind of acids, passivation to be done by ships staff on regular basis and this process must be introduced in the SMS of The Company. It depends from the vessels trade, time availability and natures of the cargoes, that ship busy with.

Passivation - is a complex job! This job consist of correct procedures for preparation of cargo tanks, correct loading procedures, correct discharging procedures and correct procedures for cargo tanks cleaning. Each of these steps is highly important to keep cargo tank and all of it elements under passive condition.

There are several types of passivation. Passivation is process of removal of exogenous materials from the surface.

This process can be done by:

1. Cutting, Grinding
2. Buffing
3. Chemical attack

Normally, on chemical tankers we are using all three types of passivation, depends from the capacities to be passivated. For the cargo tanks best way of passivation is chemical attack. This process can be done in different ways. There are two types of acids, that can recover passive layer quickly and relevantly chip - Nitric acid and Citric acid. With Nitric acid there are as well two ways to perform passivation - recirculation and passivation by steam injection.

Recirculation of Nitric acid solution is the best way to get good results, this even can be achieved visually. All discoloration, produced by burns of highly corrosive acids, will be removed by recirculation. But, this method is more expensive, than injection of Nitric acid by steam. Recirculation method requires sufficient amount of Nitric acid solution to be introduced in the cargo tank for cargo pump prime. If there are heating coils inside cargo tank, it is recommended to cover heating coils by Nitric acid solution to get better results.

This solution, after first recirculation, can be transferred into another cargo tank. pH level of solution to be controlled. If level is to lean, solution to be enriched. If level is too high, solution to be diluted.

It is highly important to prepare cargo tanks in the correct way for any kind of passivation. Last cargoes to be checked. If last cargo is any kind vegoil or luboil, proper tank cleaning to be performed. Then wall wash test to be done to determine amount of grease, that remained on the surface of the cargo tank. This test can be performed by Acetone or Hexane. If test shows negative results, additional tank cleaning with caustic soda solution to be done. As result of bad cargo tank preparation you can get serious discoloration of stainless steel surface in the cargo tank. Remember - Passivation is not a tank cleaning process, it is process to recover passive layer of Stainless steel only!

After recirculation, Nitric acid solution to be transferred and tank to be left closed for a couple of hours(depends from the tank capacity and recirculation time length). After that, good tank cleaning to be performed by Fresh water only. Level of pH to be checked continuously. As soon as level will rich pH 6-7 (neutral solution), tank cleaning can be finalized and cargo tank can be ventilated. All water to be removed, cargo tank to be absolutely dry prior to perform test to determine passive film layer. For these reason two types of tests can be used - first and most commonly used is Palladium Chloride test and test, that can be performed by special measuring device like "KOSLOW Passi-tester".

Injection of Nitric acid by steam or Steam passivation is more chip passivation method in compare with recirculation. Special device for steam introduction into the cargo tank and Nitric acid ejection to be used - so called "Umbrella". Umbrella to be installed on the butterworth hatch of the cargo tank, steam hose to be attached and hose for ejection of Nitric acid. Steam have to be opened very slowly, to allow Nitric acid to atomize into the steam. Otherwise, drops of Nitric acid will be too large and they will drop directly to the bottom with no results for the cargo tank. When proper amount of steam mixed with Nitric acid has been introduced into the tank for sufficient period, steaming can be stopped and cargo tank to be closed for several hours. There is very essential advantage of passivation by steam. All cargo pipes: drop line, cargo line, both ends of the manifold up to blind flanges, PV line can be passivated as well. During steam injection these lines have to be opened to receive sufficient amount of steam mixed with Nitric acid. After settling period has expired good tank cleaning to be done by fresh water only. Same procedure, as to be done after recirculation. If steam method is used on a regular basis, it will give an acceptable result. However, prior to passivation cargo tank condition to be checked very well. If some serious discolorations can be found in the cargo tank, recirculation method is highly recommended. All checks, tests and decisions to be done by a familiar, experienced and competent person. It is well known, that all ships and all situations are different.

As well, to recover passive layer, recirculation of Citric acid can be used. This passivation method gives same results as recirculation of Nitric acid solution, but Citric acid gives more dense amount of chromium on the stainless steel surface. Cargo tank will looks more brighter after Citric acid recirculation. Same like with Nitric acid, Citric acid to be mixed with water under certain proportion to get best results after passivation. Level of pH of the solution to be controlled very strictly all the time during passivation process. After solution is transferred into another cargo tank good tank cleaning to be performed using fresh water only. After that, settling period to be done and after settling period tank cleaning by fresh water to be done once again. Large amount of fresh water to be used during both tank cleaning periods. And, step by step, this procedure to be performed for all tanks that have to be passivated. Citric acid

is organic acid and contains organic additives. If next cargo is highly sensitive, PTT test to be carried. However, passivation by recirculation of Citric acid gives really high results.

All passivation methods described above are very useful for large capacities, like cargo tanks etc. But, there many situations when only part of stainless steel material needs to be passivated. For example, small part of heating coils is discolored or some rusty spots are observed on the stainless steel surface of the cargo pump, maintenance after welding of stainless steel. In this case Pickling pasted to be used. Very effective method to recover Chromium Hydroxide film. Pickling paste normally contains nitric acid and hydrofluoric acid mixtures, which produce nitrous fumes that are strongly toxic. Pickling paste can be applied by brushes or by spraying. Always depends on type of stainless steel, what grade of pickling paste to be used.

Lets make conclusions of all information described above:

Nitric acid recirculation method - needs sufficient amount of Nitric acid, acid-resistant hoses and butterworth machines for recirculation. pH level of the solution to be monitored. Method is relatively expensive, but very effective against bad condition of the cargo tanks.

Nitric acid steam injection method - relatively chip, due to small amount of Nitric acid to be used (that depends from the capacities of the cargo tanks). It is impossible to dissolve any discolorations, trays of any burns from the surface of the stainless steel by this method. But, it is effective and sufficient treatment for the stainless steel cargo tanks, when stainless steel is under good and continues maintenance.

Citric acid recirculation method - highly effective passivation method for the stainless steel cargo tanks in bad condition (rusty spots, discolorations etc.). This method is relatively expensive and this method needs a lot of fresh water during tank cleaning, special tank cleaning procedure and long time period. And pH level of Citric acid solution to be strictly monitored.

Pickling Paste passivation - always good for small stainless steel parts, very effective, but very dangerous for human.

ALWAYS CHOOSE THE RIGHT SOLUTION!

