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Service Reference

Topic: Fast Dissolution of 316L Electrodes

Please read all the instructions listed below to familiarize yourself with the project before unpacking any further or attempting to perform any of the work.

Required Materials

- Anolyte Anti-Corrosive Additive

Required Tools

- Weight Scale

Generally an issue only seen with cathodic ED systems, the rapid dissolution of the anodes comes as a surprise. This alloy, while ultimately sacrificial as an anode, does have an interesting property. As it begins to dissolve (it only takes about 2 volts) in a conductive liquid media, it develops a complex conductive layer at its surface of Ni, Cr, and Mo. This conductive layer attempts to protect the alloy from further degradation, but it is never enough as even the best 316L alloys will wear away at rates of about 10 μgram/Coulomb, or less. One Coulomb equals 1 amp for 1 second. Wear rates in excess of the theoretical maximum (about 220 μgram/Coulomb) have been observed because the alloy's structure has been so weakened under these extremely high wear rates that small bits fall off, thus increasing the observable mass loss.

316L stainless alloy is considered sacrificial because the voltage required to break down the water molecule is greater than that required to liberate some of the electrons of the Fe in the alloy. Since e-coat does rely on the hydrolysis of water the Fe in the alloy is always losing electrons. One way to better understand this is to consider the DC rectifier as an electron pump. The suction side of the pump is the anode and the cathode is the discharge side. The electron pump gets most of its electrons from the hydrolysis of water. If something or a combination of things act in such a way to obstruct the suction side of the pump, then the pump will begin to cavitate. But the pump never cavitates because it remembers it has an alternate source of electrons (from the Fe present in the alloy) and this electron pump continues to circulate electrons as before. However, there is only a limited amount of Fe in the stainless steel Electrode and so when all of the Fe is exhausted the E-coat system shuts down.

It is a very difficult task to identify the specific causes when a customer experiences fast dissolution of their stainless steel Electrodes. Generally, there are at least two contributors: chloride ions and other organic contaminates. Complex organic contaminates can form inside the Cell and create a 'gel' layer on the face of the Electrode. Generally, this gel layer acts like an insulator, which then increases the current density on that portion of the Electrode without the gel layer. Chloride ions are well known to be very aggressive at oxidizing the iron from the stainless alloys.

There are three things you can do to help yourself, firstly never allow city water (or other high conductivity water) into your e-coat paint system; secondly add a good quality carbon filter to the DI water system, and lastly ask your E-coat paint supplier for their recommendation of an appropriate additive to reduce the chance of a high dissolution problem (UFS can help your E-coat paint supplier in this selection process).

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1. Record the color of the anolyte every day by comparing it to a paint chip sample (from your local hardware store). If the anolyte color has turned dark, like coffee or coke, then this may already signal that there is an increased amount of iron oxide in the anolyte.
2. Add the anolyte anti-corrosive additive (recommended by your ED paint supplier and UFS) on a regular basis (two or three times a week) since the anolyte is always being turned over and lost as the conductivity controllers adds fresh DI water.
3. To begin a process, weigh a sample of the Electrodes every six months or so. Graph this data and use it to predict when to replace your electrodes (generally when you have less than 40% of the original mass left). See Bulletin #990129, to establish a weight sampling program for stainless steel Electrodes.
4. Change the carbon filter on a regular basis to make sure if is operating properly.

For more information see the original manual that came with the equipment or call UFS at the phone number shown above.

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Think and act in a safe manner. Always disconnect power and use a lockout before you work on the E-coat system, or any of the related subsystems. Observe any confined space conditions. Use the appropriate safety equipment & clothing for the task.
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