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Service Reference

Topic: Fast Dissolution of Precious Metal Electrodes (PME)
"My inert Electrodes are wearing out fast!"

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
- UFSc Service Reference 990127 (Parameter Values Recording Form)
- UFSc Service Ref 990161 (PME Insp)

Required Tools

- Portable "X-ray Machine" for evaluating PME coating or 10x scope if necessary

Generally an issue only seen with Cathodic ED systems, the rapid dissolution of the PMx (precious metal type) anodes comes as a surprise. What is fast dissolution of PMx? Once the PME coating has lost about 30% of it's original coating, the anode (Titanium) surface is at risk for developing pits *(Figure 1)* and you should think about replacing them. The pits generally start low on the anode on the side facing the ware. In some cases the pits then migrate around the bottom of the anode, or in other cases the pits migrate up the face of the anode on the side closest to the ware.

Typically, these PME operate ideally when used in white/light cathodic paint at a current density of 3-5 Amps/square foot of anode area.

Note: Precious Metals coated Titanium anodes are used only in a Cathodic E-Coat System. They are <u>not</u> to be used as a cathode.

The PME Membrane Electrode sold at UFSc is a mixed metal oxide catalyst coated on a titanium substrate. The PMx is used as a high current density oxygen-evolving anode, which is more dimensionally (i.e. less soluble, or sacrificial) stable during operation than 316L stainless steel. It is most often used with white or light colored Cathodic paints that are sensitive to iron contamination. If local water discharge rules are severe, then PMx anodes will dissolve and typically release Ti and precious metal oxides into the anolyte solution.

Operating Factor	Level of Concern	Possible Effect to Anode
Current Reversal (including back EMF and battery effect)	15 minutes every 3 days Once every 3 hours Once every minute	Approximately 25% loss of life. Approximately 50% loss of life. Approximately 90% loss of life.
Temperature	60 - 80°C (pH <2) 5 - 90°C (pH 2-12)	Approximately 50% loss of life. No loss of life predicted.
Alkaline Electrolyte	> pH 12	Hot caustic may result in accelerated coating loss.

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.more

Figure 1. (Surface Pitting)

Figure 2. (Typical Loss of Coating)

Typical Failure Modes

Figure shows how pits have penetrated through the Ti tube. Figure 2 shows light colored regions. Generally these light colored regions have a color close to 'battle ship' gray. The third failure mode is referred to as loss of adhesion (between the PMx oxide coating and the Ti tube). This is evident if you hold the tube and then look at your hand. If you see black material on your hand then this may be an issue. It is typical to see some amount on you hand, but the more than comes off indicates a failure is in progress.

In some cases detailed examination using x-ray and other methods can be performed at no extra cost. Please contact customer service for information on this option.

It is a very difficult task to identify the specific causes when a customer experiences fast dissolution of their Precious Metal coated Electrodes. The following is a list of possible contributors to excessive corrosion of Precious Metal Anodes and the possible effects they may be having on Anodes:

Anolyte Component	Level of Concern	Possible Effect to Anode
Fluoride	1 – 5 ppm	Premature loss of coating due to attack of titanium substrate.
Bomide	50 ppm	Reduced titanium breakdown potential if

Anolyte Component	Level of Concern	Possible Effect to Anode
		electrode is deactivated.
Cyanide	1 ppm	Premature coating failure due to complexing of the precious metal in the coating.
Manganese	50 ppb	Higher anode potential due to deposition in MnO_2 resulting in reduction of coating life.
Lead	2 ppm (non-chloride electrolyte)	Plating on anode surface causing localized high current densities and possible shorter coating life.
Barium	1 ppm (sulfate electrolytes)	Deposition of barium sulfate on anode surface will cause high localized current densities and higher anode voltages.
Strontium	30 ppm (sulfate electrolyte)	Deposition of strontium sulfate will result in high current densities, high anode voltage, and possible shorter anode coating life.
Organics	1 ppm	EDTA causes coating loss *(Figure 2)* and premature coating failure. However, each organic must be addressed on a case-by-case basis. Some organics form a deposit on the anode coating which will result in increased voltage.

There are several things that should be done: 1) Never allow city water (or other high conductivity water) into the e-coat paint system; and 2) Ask the E-coat paint supplier for their recommendation of an appropriate additive to reduce the chance of a high PME dissolution problem. (UFSc can help the E-coat paint supplier in this selection process.) 3) Be careful not to allow halides to enter the ED paint bath of the anolyte solution. These are sometimes used as active ingredients in fungicides and biocides.

Here are some other suggestions:

1. Record the conductivity of the anolyte every day on a bulletin that is offered by UFSc (Service Reference #990127).
2. Record both the ED Bath pH and the anolyte pH on above mentioned Service Reference #990127.
3. Add the anolyte anti-corrosive additive (recommended by the ED paint supplier and UFSc) on a regular basis since the anolyte is always being turned over and lost as the conductivity controllers add fresh DI water.
4. Begin a process of visually inspecting (with hand-held or portable 10x microscope) a sample of the PMx every six months or so. Graph this data and use it to predict when to replace your electrodes (generally when you have less than 30% of the original coating mass left – as measured with an x-ray test instrument).
5. Record a process by which you inspect the PMx for excessive corrosion. (Request UFSc Bulletin #990161.)

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