Membrane Electrode Cell - Best Practice Quick Reference Sheet

2012

Formulas

Electrode surface area is estimated using one or more criteria (Rule) listed below:

- 4:1 Ratio: Anode area is equal to 2 minutes worth of painted through-put / 4. For automotive systems, use 2.5 minutes.
- Electrode Current Density: When total amp amount is divided by the amount of anode area, the figures should not exceed 35 amps/ SF (3.5 amps/SM) for high through-put systems that need redundancy; or as much as 5 amps/ SF (50 amps/SM) for industrial E-coat paint systems.
- Center-to-Center Cell Spacing: The center-to-center between ME Cells should be no more than 5 x & no less than 1 x the circumference (or arc length) of the electrode.

Glossary of Terms

Some common terms are defined below:

- Anode: Positive side of the DC rectifier
- Anodic Paint: Ware is the anode
- Cathode: Negative side of DC rectifier
- Cathodic Paint: Ware is the cathode
- Electrode: The metal part connected to the bus bar. For cathodic paint, it is the anode. For anodic paint, it is the cathode.
- Electrolyte: Fluid inside the ME Cell. For cathodic paint, it's called anolyte. For anodic paint, it's catholyte.
- Ware: Object or part being painted

ME Cell Configurations

There are several different types of Membrane Electrode Cell designs or configurations, including:

- Open Top: The most common and typically the least expensive since it has fewer parts.
- Closed Top: Sometimes called Low Profile or Pressurized, has a Bulkhead Fitting. Does not require as much space above the rim of the tank. Use PTAN membrane to minimize anolyte loss.
- Horizontal (i.e. Roof or Floor): Note the electrolyte discharge must be at the 12 o'clock position and sloped upwards at 2% to allow oxygen to leave the Cell. Use 16 lpm / sm (4 gpm / 10 SF).
- Geometries: Crescent, Box & Tubular: Box cells have the least amount of membrane; tubular have the greatest amount.

Vigorous Electrolyte Flow

24/7 motion of the electrolyte promotes better cooling to extend electrode life & expel the oxygen that can cause corrosion:

- 8 lpm / sm (2 gpm/10 SF) + 20% to size electrolyte pump
- Size supply manifold at 3-5 fps (1-1.5 mps) velocity.
- Size return manifolds for no more than 3/4 full.
- Do not mix up the supply & return tubing connections for Closed Top Cells as the Cell can fill with oxygen & current will go to zero.
- PVC tubing with 3/32" (2.3 mm) min. wall thickness
- Use 90° hose barbs to avoid kinked PVC tubing.
- Limit supply pressure for Closed Top Cells to 7 psi (0.5 bar) to avoid over pressurization & membrane failure.

Fungus

Stagnant, warm electrolyte fluid will promote the growth of fungus. Some preventive actions to take:

- Electrolyte Pump: Do not turn off, keep operating 24/7.
- Raise Electrolyte Conductivity: The higher the conductivity, the less attractive the food source. Talk to your paint supplier to discuss an increase to 1,800 or 2,000 micro S/cm to help reduce fungus.
- UV lamp: If your DI water or RO water is stored in a tank, is there a UV lamp on the recirculation loop?
- Approved Biocides: Use approved biocides in the electrolyte tank. Avoid those with halides such as chlorine and bromine as they may accelerate corrosion of the 316L anode.
- Limit Hydrogen Peroxide: To 3% strength and no more than 2 or 3 consecutive cleanings with paint company approval.

Preventive Maintenance

Several activities can be performed during the year that may pay benefits, reduce surprises, & lessen down-time:

- Do not mix new and old ME Shells together. Keep new Shells away from older Shells, so they all share the work as equally as possible.
- Keep electrical connections tight with use of spring washers.
- Train personnel on Confined Space & Lockout/Tagout procedures.
- Repair membrane tears less than 1 in (25 mm) with membrane repair kit. Avoid membrane contact with strong oxidizers.
- Use a carbon filter as part of the DI water system & discuss with paint vendor use of nitric acid to reduce 316L corrosion.
- Record mass loss of SS Electrodes, rotate Tubular Electrodes 120 deg 3 x a year, or visually inspect precious metal anodes.

Materials of Construction

ME Cells are made from ion-exchange membrane, metal electrode, and a plastic housing:

- PTAN Membrane: Pressed sheet style with the best mechanical properties and the least amount of water permeability.
- PTAR Membrane: Reduced cost membrane produced in 30 m rolls. Not recommended for Low Profile applications since the water permeability is 2 x that of PTAN membrane.
- 316L Stainless Steel: The primary choice for anode material. Do not use 304, 302, or 17-8 stainless alloys as they have short lifetime.
- Precious Metal: Either ruthenium or iridium oxide coated over a thin titanium tube. Cannot be used as a cathode.
- Housing: Fiberglass, PVC, or polypropylene is normally used.

Baseline Data

Every system will change as it is operated. When trouble occurs, baseline data provides a valuable basis for comparison:

- Voltage: Each different ware package may require a slightly different voltage to achieve the customer's film thickness requirements. Use the TruIDL Voltage Logger to investigate the voltage profile of the ware as it moves through the E-coat bath.
- Electrical Current, Amps: The ability of the ME Cell to deliver work and a measure of how resistive the Cell is. Readings should be recorded every 3 months for the largest ware.
- Conductivity & Temperature: Monitor these two parameters of the electrolyte circulation system and record daily.
- Record when Shells are installed as they have a finite life.