

TECHNICAL REFERENCE

TOPIC: ELECTRODE AREA CALCULATION

Electrode area can be determined by using several different methods and then reviewing the results to make an informed decision. These methods include the 4-to-1 rule (most commonly used; is based on a 2 minute dwell time), the 2.5 minute rule, average Electrode current density, and Cell center-to-center spacing.

If your ED system has less than a two minute dwell, or the film build is greater than 25 μ (1 mil), the 4:1 rule will undersize the Electrode area required. Conversely, if your system has more than a two minute dwell, or you want to apply less than 25 μ (1 mil), the 4:1 rule will oversize the required Electrode area. In these instances, use the Electrode current density method to provide better results.



DATA COLLECTION

The first step is to gather pertinent ED system information, including operating parameters, ED tank parameters, and ED tank dimensions. The information requested in Sections B and C of the ED Tank Survey (Bulletin #999101) serves as a good outline for completing this step.



4:1 RULE

The 4-to-1 (work area-to-Electrode area) rule was developed from empirical data and provides a very suitable result if the ED system has two minutes of “power-on” dwell time and the user wants to apply 25 μ (1 mil) of ED film.



Work Area Basis: The “Work Area Basis” (WAB) is the area that passes in front of a Membrane Electrode Cell in two minutes. (Two minutes is arbitrarily selected for the purposes of calculation, and thus is fixed regardless of your actual dwell time.)

$$\text{Work Area Basis} = \frac{\text{Jobs}}{\text{Hour}} \times \frac{\text{Area}}{\text{Job}} \times \frac{1 \text{ Hour}}{60 \text{ minutes}} \times 2 \text{ min}$$

Electrode Area Basis: Divide the WAB by 4. The result is the suggested amount of Electrode area, or “Electrode Area Basis” (EAB).

2.5 MINUTE RULE

Used by some automotive ED systems, this is a variation of the 4 to 1 Rule. It results in 25% more Electrode area because the WAB is calculated using 2.5 minutes rather than just 2 minutes.

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AVERAGE ELECTRODE CURRENT DENSITY

This technique uses an Electrode current density limit of 50 amps per square meter (about 5 amps per ft²). Using this limit to calculate the Electrode Area means that there can be no increases in such items as conveyor speed, required ED film thickness, etc. Most high painted through-put systems use a more conservative 30 amps/sm (about 3 amps/SF) for the Electrode current density.

For new ED systems, an estimate of the current demand is required. (Refer to Bulletin #991003 *Electrocoat Current Draw* for additional information.)

$$\text{Average Current Density} = \frac{\text{Highest Current Draw (not rectifier rating)}}{\text{Total Electrode Area}}$$

If the average current density is greater than 50 amps per square meter (about 5 amps/ft²), then more Electrode area should be added to reduce the current density.

Test data has shown that for Membrane Electrode Cells with Electrode current densities greater than 50 amps per square meter (about 5 amps/ft²), the useful life of the Electrode (and Membrane Shell) is reduced significantly.

CELL CENTER-TO-CENTER SPACING

The center-to-center distance between TECTRON™ Membrane Electrode Cells impacts the average electrical resistance of the ED system. The greater the center-to-center distance, the greater need there will be to increase voltage. On the other hand, as the

Center to Center Distance Recommendations		
Cell Size	minimum	maximum
1-1/2"	150mm (6 in)	750 mm (29.53 in)
2"	200 mm (7.87 in)	950 mm (37.4 in)
3"	300 mm (11.81 in)	1425 mm (56.10 in)
5"	450 mm (17.72 in)	2250 mm (88.58 in)

Cells get closer and closer together, less voltage is needed. However, at some point the benefit of moving the Cells closer together is lost. Please refer to the table below for more information.

Monorail Conveyor – For tanks with TECTRON Cells on the two long sides of the ED tank:

$$\text{Cell Spacing (Center - to - Center)} = \frac{\text{"Power - On" Zone Length}}{(\text{Number of Cells} - 1)}$$

Hoist Conveyor – Cells usually are evenly spaced over the width of the ware package (on each of the long sides of the ED tank). In some cases, Cells can be placed on all four sides of the tank, if the aspect ratio (plan view) is close to 1 to 1. Refer to the average center-to-center distance in the table below for recommended Cell spacing.

TECTRON™ ELECTRODE CELL SELECTION

The effective length of the TECTRON Cell is the exposed height of the ion-exchange membrane below the surface of the ED paint. The effective height of TECTRON Cells can range anywhere from less than 0.6 meters to 2.9 meters (24 inches to 114 inches). There are, however, certain standard sizes that represent the more economical sizes of cells to build. Those standard effective heights are 1, 1.4, 1.9, and 2.9 meters. Whenever possible, it is best to select one of the standard sizes and make sure it approximates, or is even a little longer than the work package. To calculate the number of TECTRON Cells required, first multiply the Cell's effective length by by the Electrode effective area (see chart below). Then divide the total Electrode area by the electrode area of each Cell.

Electrode Effective Area Per Unit of Length		
Cell Size	Metric	English
1-1/2"	0.15 m ² /m	0.49 ft ² /ft
2"	0.19 m ² /m	0.62 ft ² /ft
3"	0.279 m ² /m	0.92 ft ² /ft
5"	0.444 m ² /m	1.46 ft ² /ft