Successful Implementation of Insoluble Anodes in a Vertical Plating Acid Copper Tank at Electrotek Corporation in Oak Creek WI.

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EXECUTIVE SUMMARY

The use of an insoluble anode in place of standard copper anodes (slab or titanium baskets filled with copper) improves the quality of plating, increases the productivity of the plating line, reduces cost and reduces waste.

The insoluble anode is used extensively in conveyorized acid copper plating equipment; however its use in standard acid copper plating tanks had a series of false starts that slowed its acceptance in the industry. Very high consumption of additives was the foremost reason that most attempts were abandoned. Difficulties in copper replenishment were also among the reasons why the system did not take off as expected.

This paper will highlight the advantages that the use of an insoluble anode brings to acid copper plating of PWB's. It will report on how the consumption of additives was understood and contained. It will discuss replenishment methods that are both economical and implementable.

The paper will present the data from the implementation of insoluble anode at Electrotek Corporation. The data will show the quality and productivity improvements, as well as cost and waste reduction in acid copper plating.

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IPC Midwest Conference and Exhibition
Schaumburg, IL
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SCOPE

Project

To replace the existing manual line with a state of the art plating system.

Objectives

- **To increase acid copper plating productivity**
- **To plate higher aspect ratio thru holes (>12:1)**
- **More uniform surface thickness distribution (isolated traces vs ground plane areas)**
- **Fine line plating (3/3mil)**

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APPROACH

Quotations and specifications were solicited from a number of equipment manufacturers.

Settled on a quote from RBP Chemical which entailed the co-ordination between Uyemura and ME Baker to spec out the line.

Uyemura to spec out its plating requirements and ME Baker to deliver a “state of the art” automatic vertical plating equipment.

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CHEMISTRY

Uyemura was offering its EPL bath. EPL is a high throw bath that operates in DC mode.

Uyemura uses CVS control as an analytical tool.

Uyemura was recommending an insoluble anode for this endeavor.

INOSOLUBLE ANODES

Advantages:

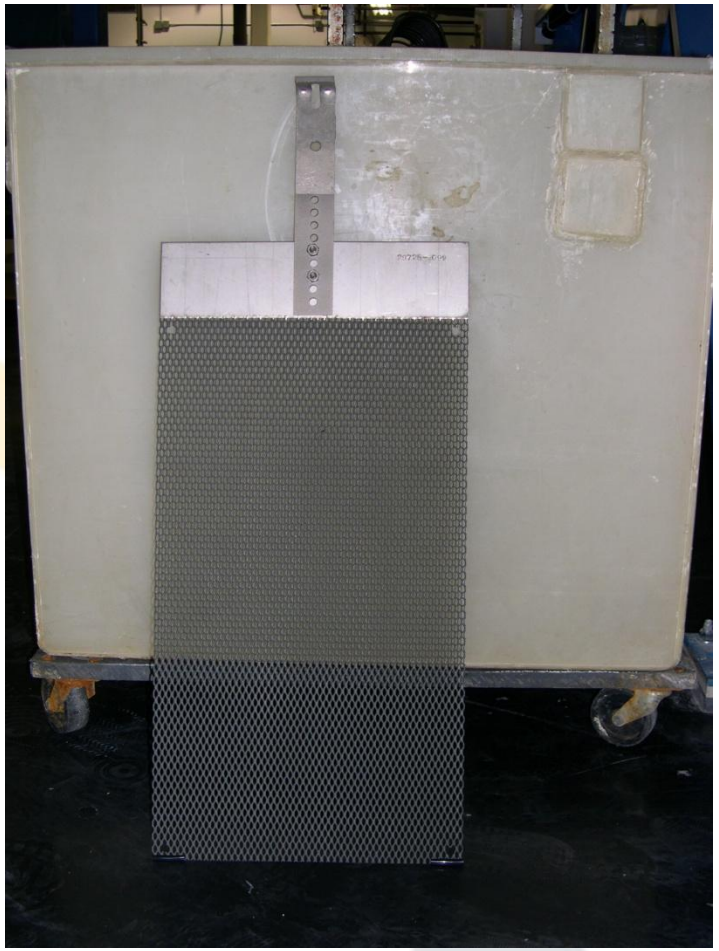
- **Improve uniformity of surface thickness**
- **Reproducible performance day to day, cell to cell and bath to bath**
- **Eliminate the need to dummy plate**
- **Eliminate copper waste altogether (no copper growth, no anode scrap)**

Limitations:

- **The anode produces oxygen gas when plating.**
- **Needs an external source for Cu replenishment**

THE INSOLUBLE ANODE

The anode is a titanium expanded mesh.
The titanium is coated with an iridium oxide coating.
The Iridium oxide coating is then coated with a patented "Synergy Coating"
The anode is made by DE NORA and distributed by Network Electronic Marketing of Phoenix AZ



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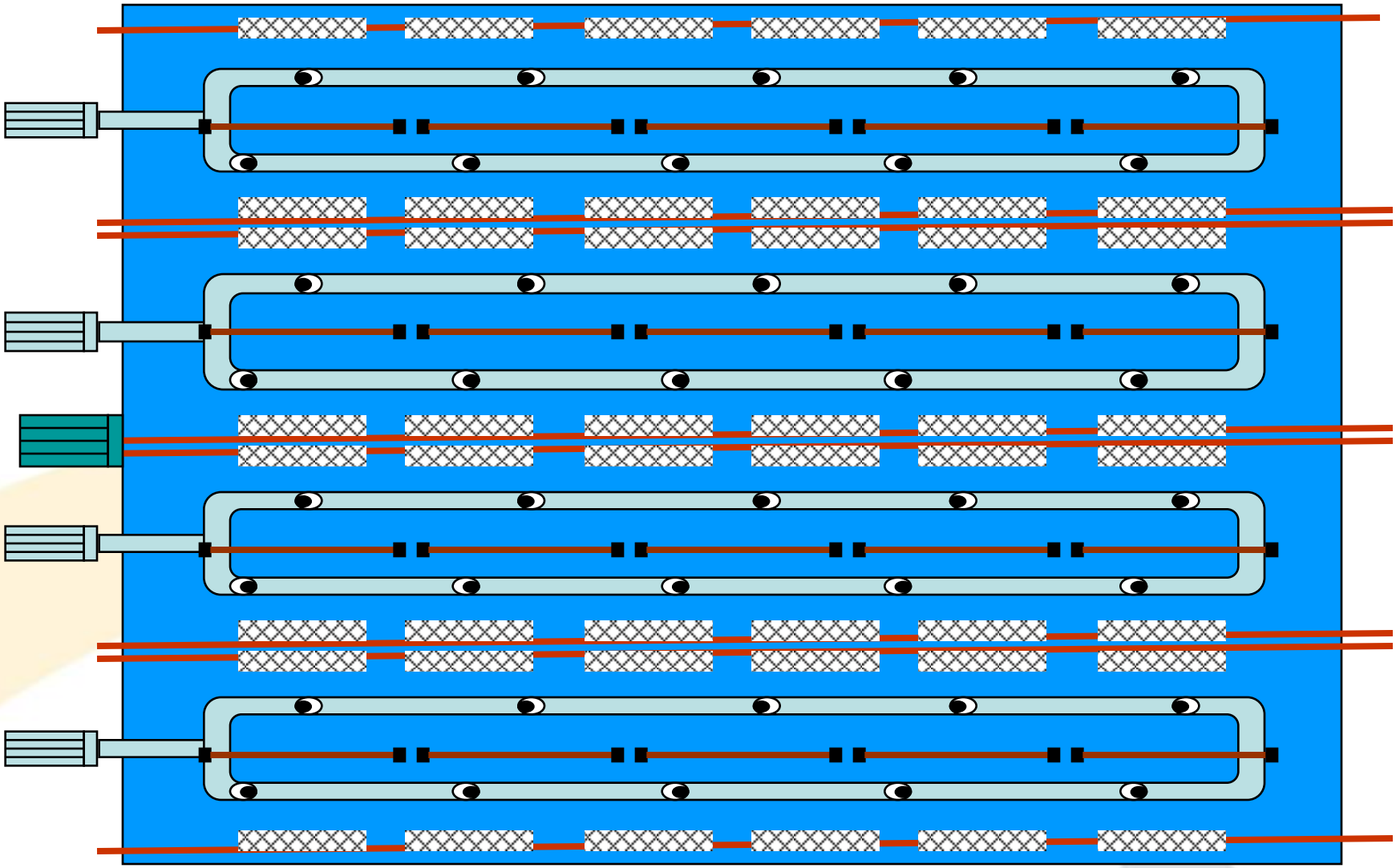
The Plating Tank 1 of 2



Top View

Bath Volume 6800L

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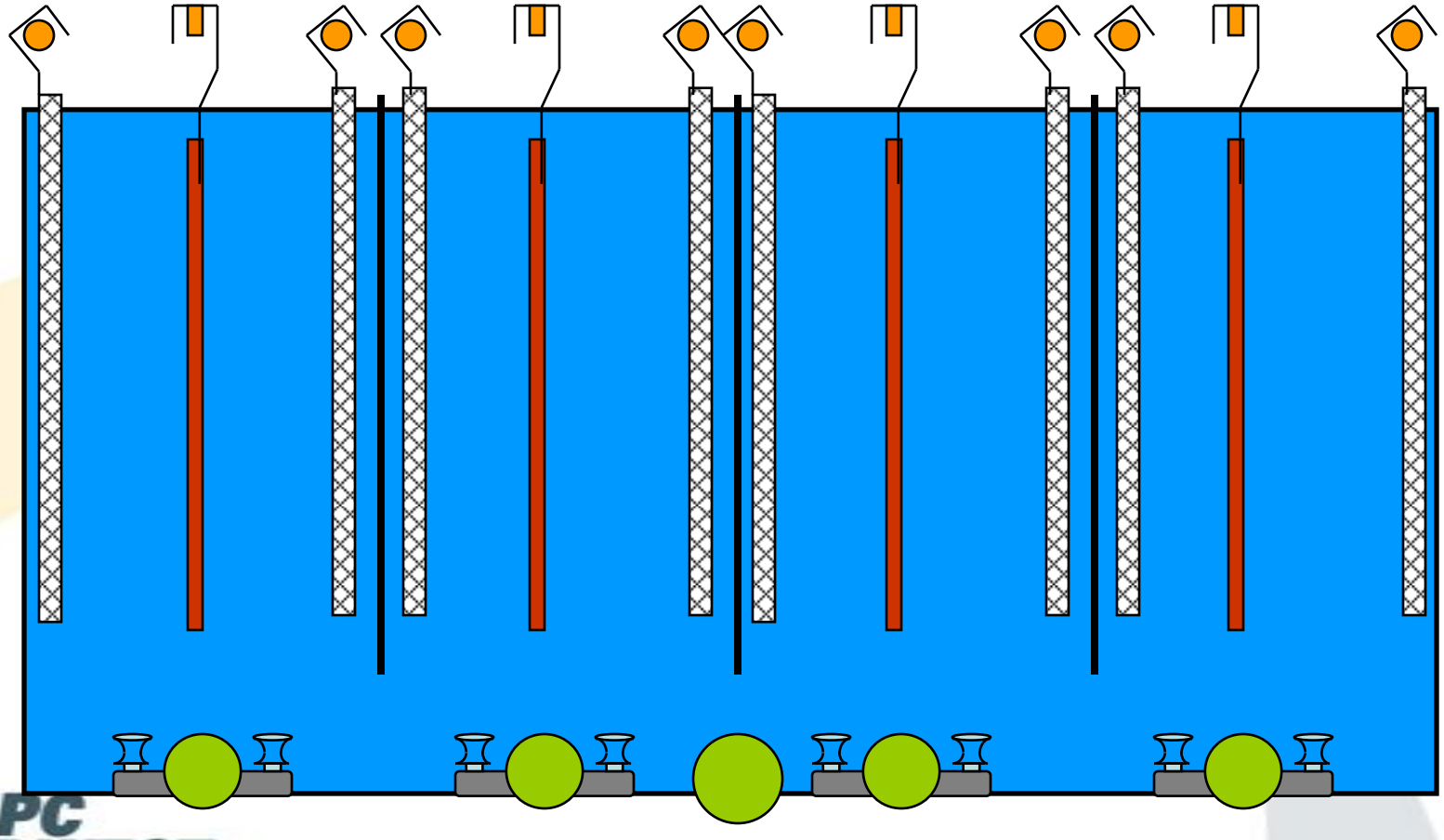
The Plating Tank 2 of 2

4 Plating cells equipped with dual rectification and E-ductor solution agitation. Bath volume: 6800 L



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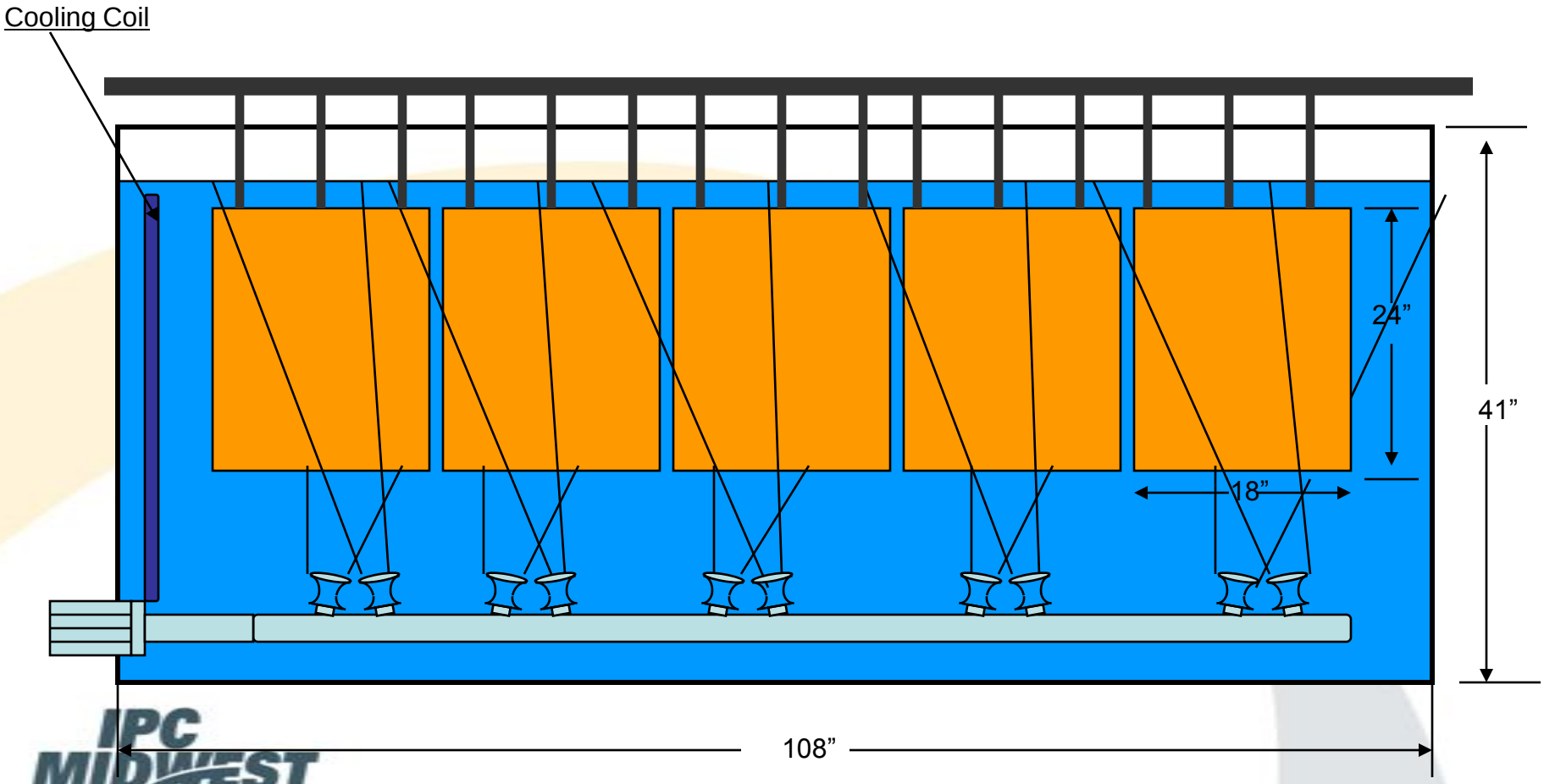
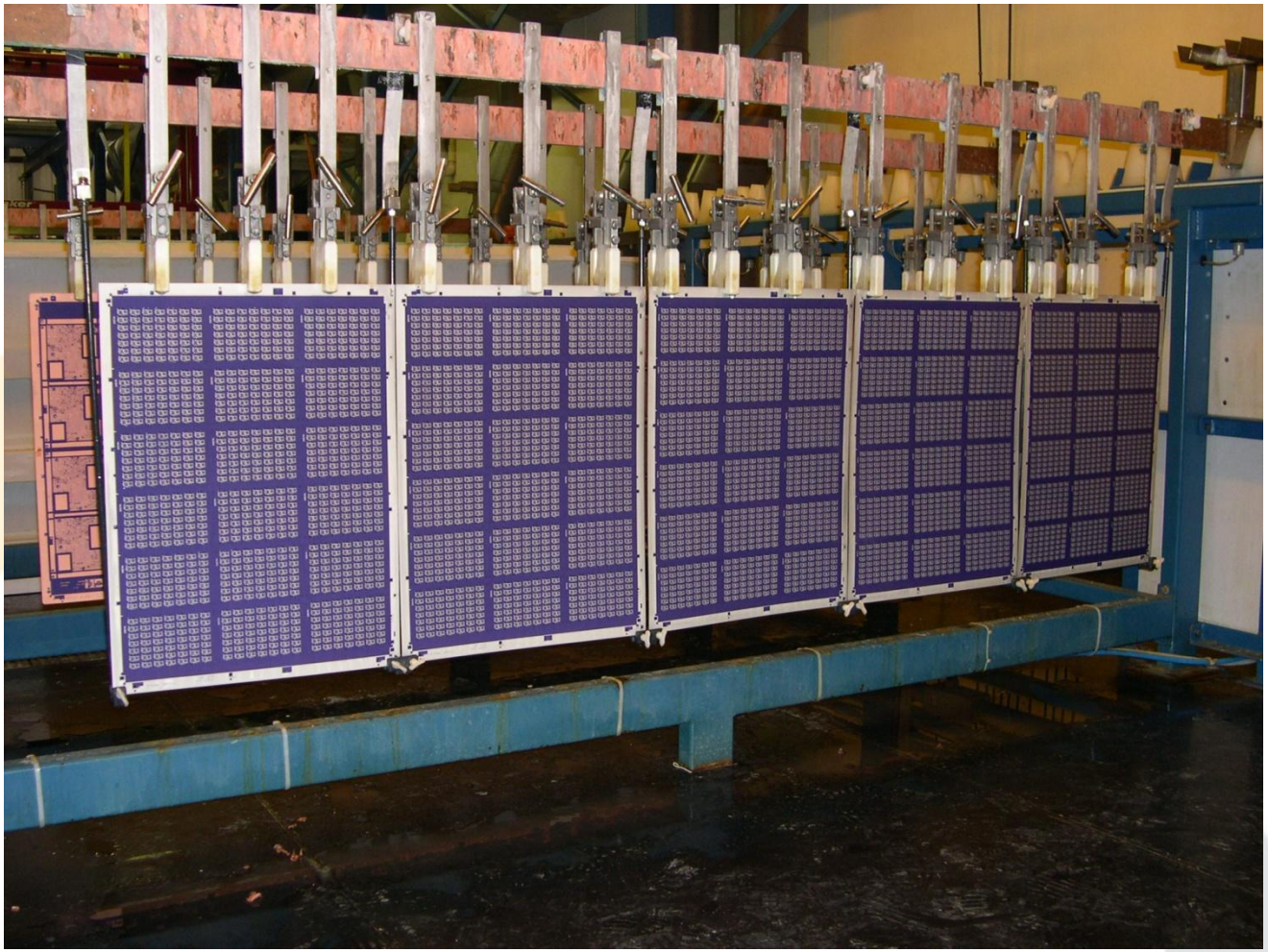
E-ductor Configuration

Opposing front and back, bottom E-ductor offset from vertical, to maximize Mass Transfer thru the holes



Cathode Configuration



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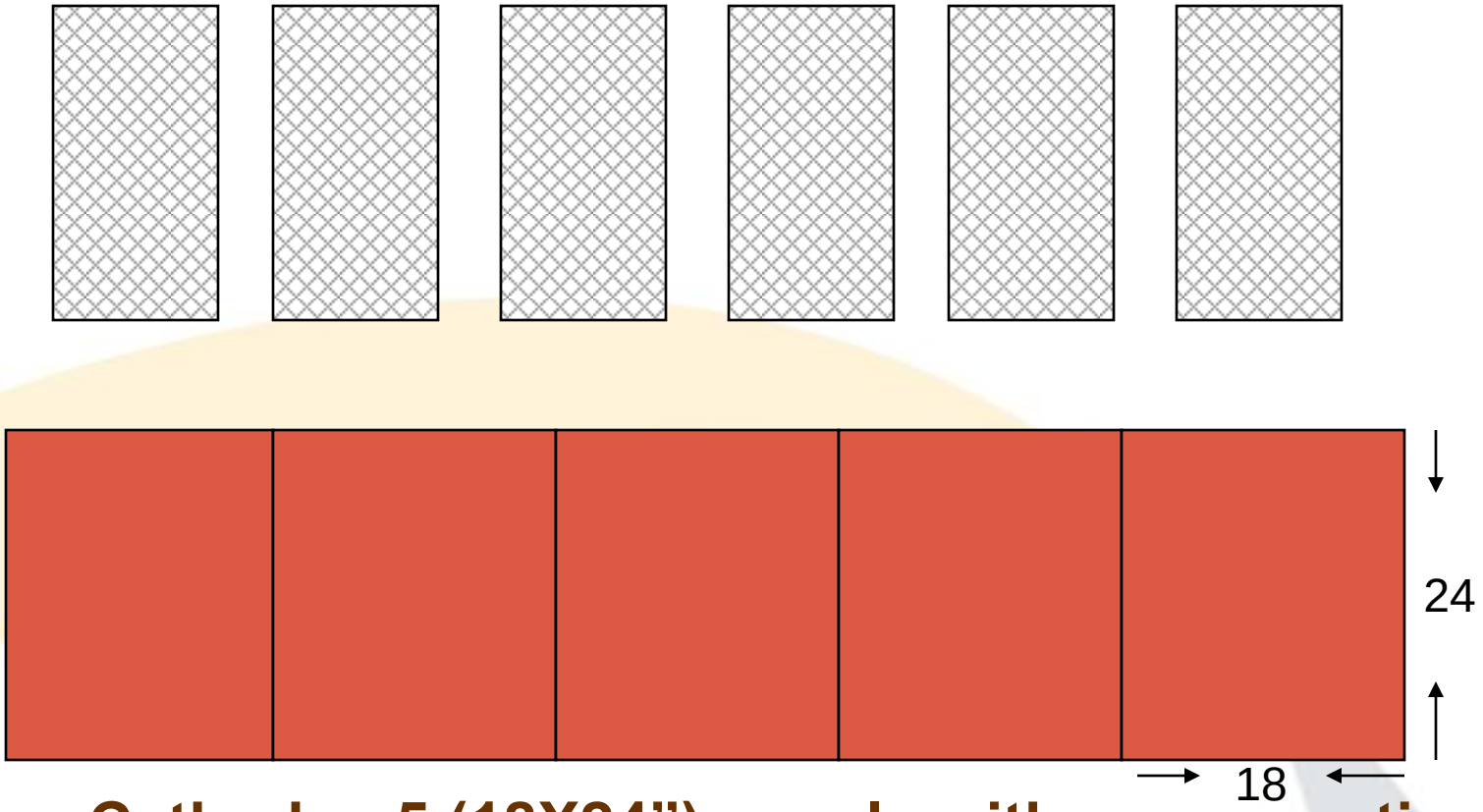
Anode Configuration (18 X 24”)

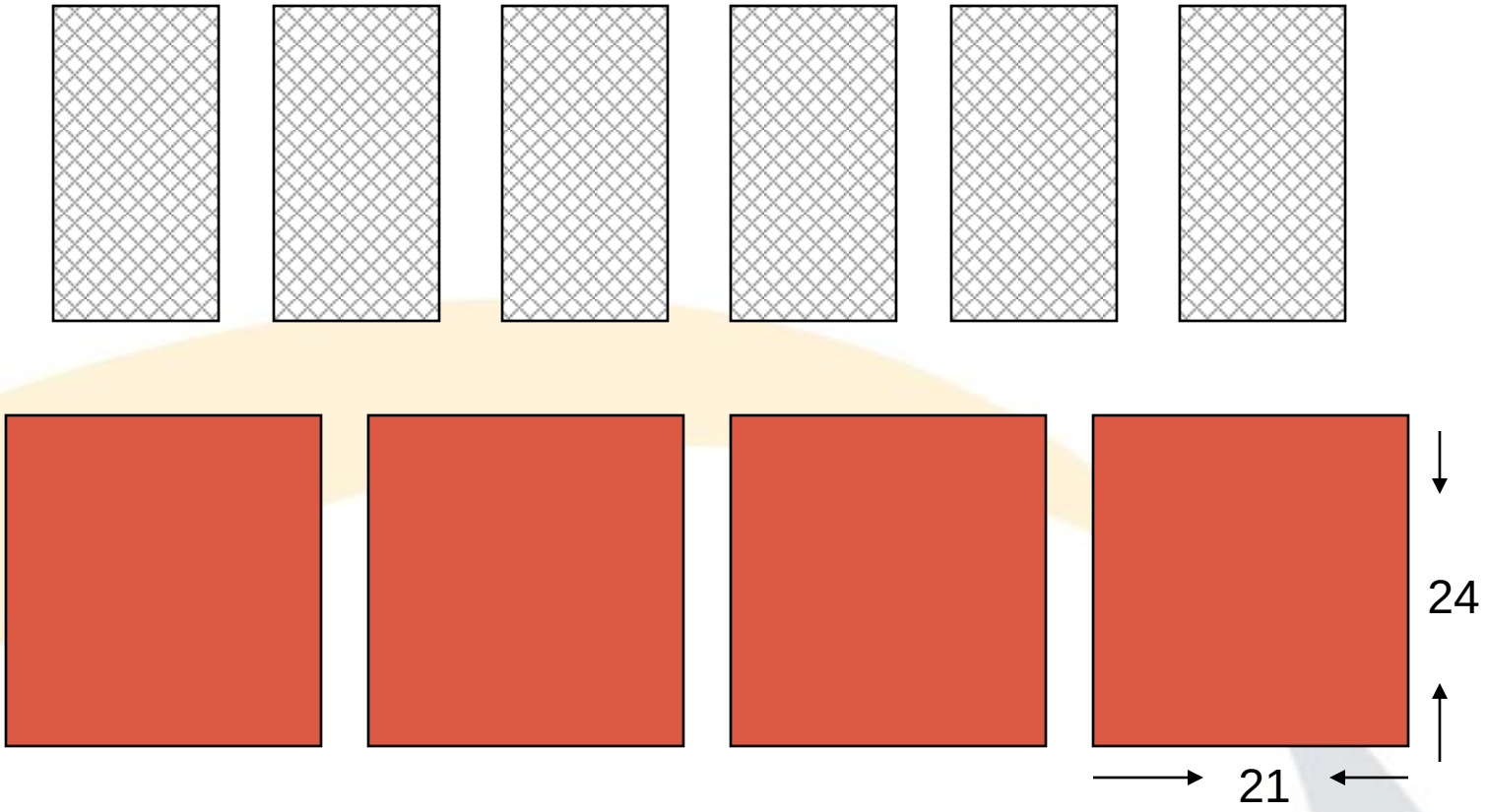
6 anodes spaced out evenly.



Cathode: 5 (18X24”) panels with no separation, cathode dimensions 24 X 90”

Anode Configuration (21 X 24”)

No change in anode configuration



Cathode: 4 (21X24”) panels, with 2” separation, cathode dimensions 24 X 90”

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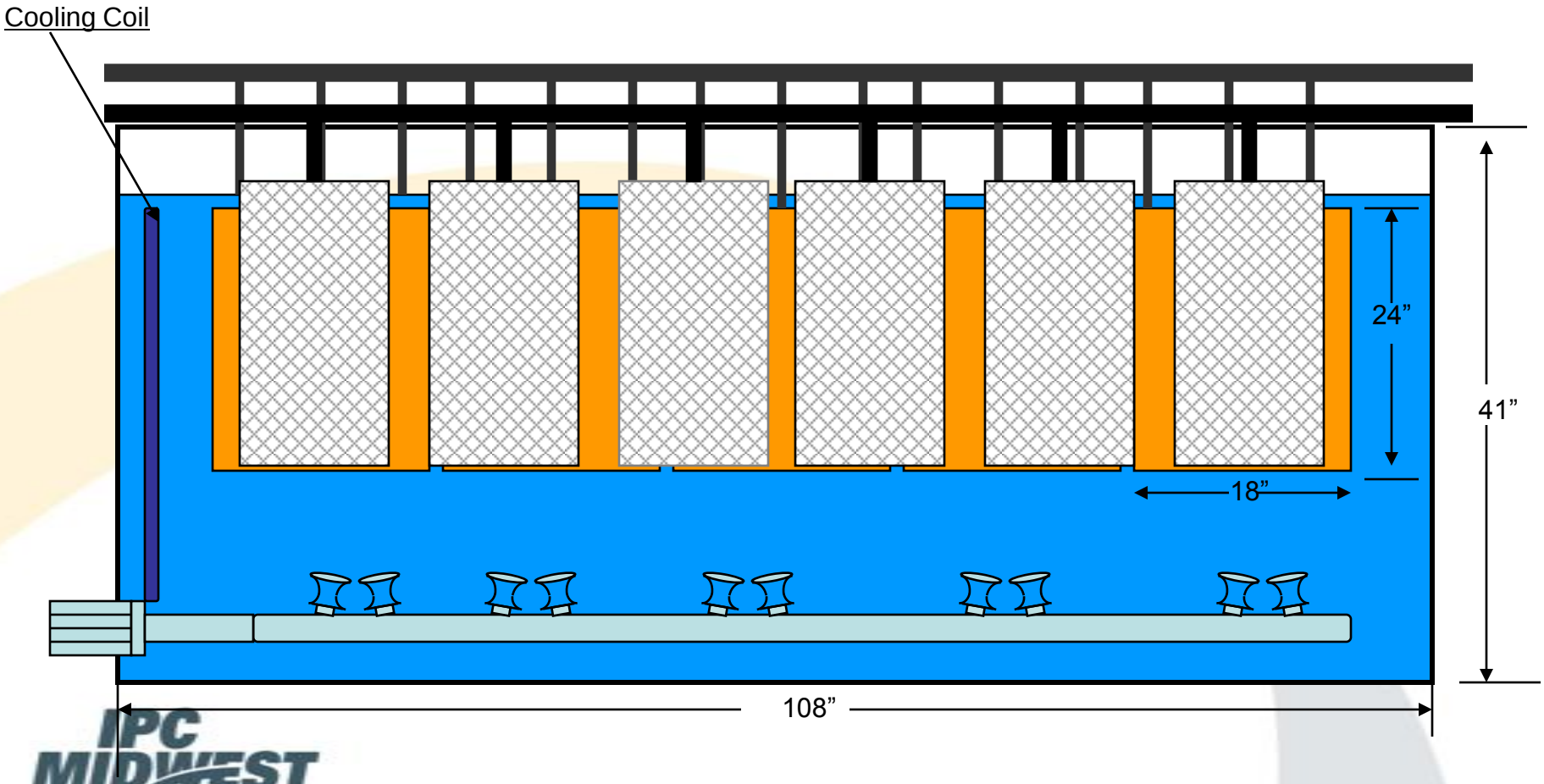
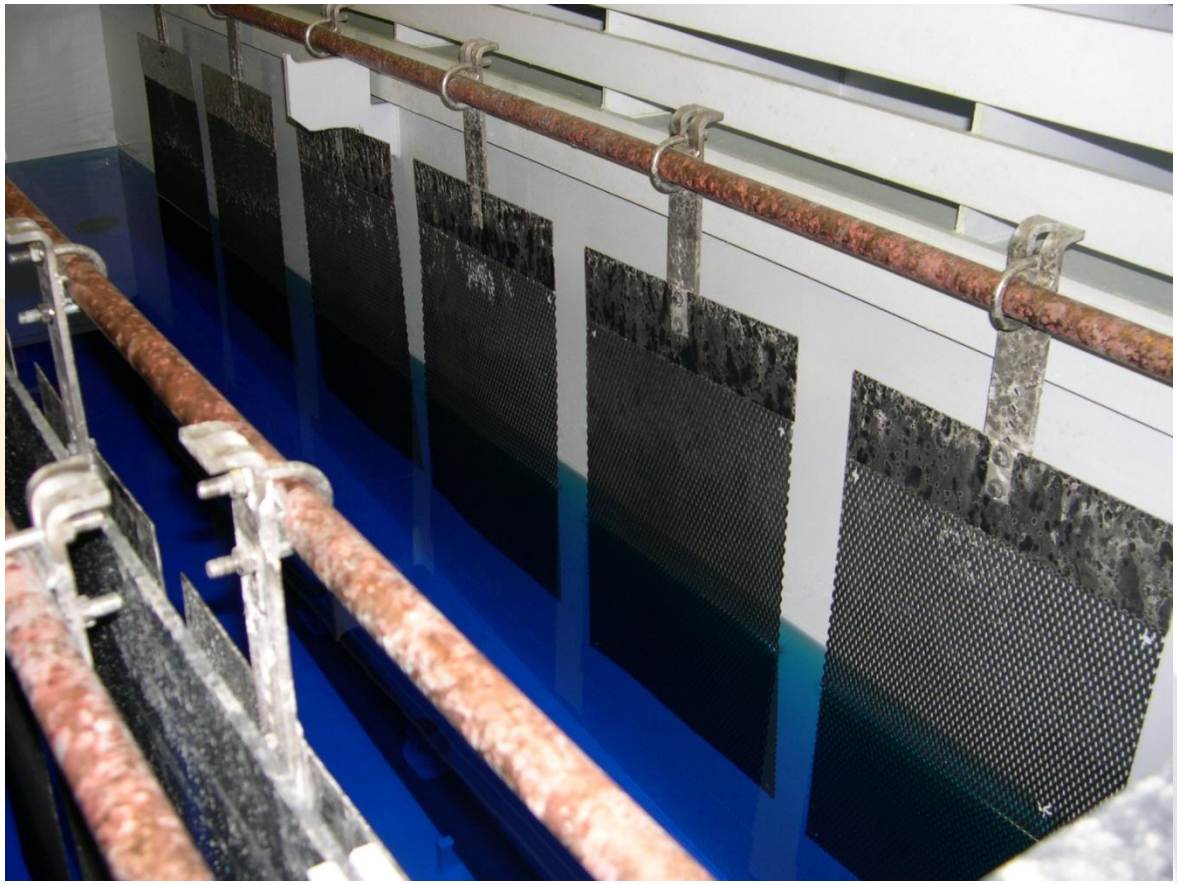
Anode Configuration



Anode Configuration

(Picture taken as bath is filled up)



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Part Agitation

Part Agitation is not necessary.

E-ductor solution agitation is more than adequate.

Presently agitation is set at 1”stroke at 6 rpm.

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Copper Regeneration

- The basis of Regeneration is “Air Oxidation” of Copper Wire.
- The bath is circulated thru the “Gobbler” copper bed with air sparging.
- Copper metal is oxidized to copper ions.
- Copper Gobblers come in different sizes. The one pictured is a 3.0 lbs/hr system

Copper Gobbler™
Optimum Technologies
Distributed by
Networks Electronic Marketing
Phoenix AZ

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ADDITIVE CONSUMPTION

Bath Loading: 900 Amps, Gobbler ON

Time	EPL-A 0.2–0.7ml/L	EPL-A addition liters	EPL-B 10-40 ml/L
3:20pm	0.46	3.2	13.4
4:30pm	0.28	No add	10.5
5:30pm	0.13	2.0	No Analysis
5:45pm	0.28	No add	8.6
6:30pm	0.09	No add	4.9
USAGE:	Very High		Very High

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ADDITIVE CONSUMPTION

- **EPL-A Brightener**

  Very high consumption (~1750 ml/KAHr)
- **EPL-B Carrier**

  Carrier is breaking down.

Turn OFF the Gobbler to determine where the high consumption is coming from?

Is it the Anode or is it the Gobbler?

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ADDITIVE CONSUMPTION

Bath Loading: 900 Amps, Gobbler OFF

Time	EPL-A 0.2-0.7 ml/L	EPL-A addition liters	EPL-B 10-40 ml/L
10:30am	0.39	3.2	11.0
1:30pm	0.12	2.0	13.2
2:30pm	0.15	2.0	11.0
3:40pm	0.20	2.0	12.9
4:45pm	0.10	No add	11.4
USAGE:	Very High		NORMAL

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ADDITIVE CONSUMPTION
The Gobbler

- The flow rate thru the gobbler was 10 gal/min
- At that rate the bath volume would be turned over every 10 – 11 hours.
- The gobbler could be used off line to dissolve copper in a batch mode and then make adds as needed.
- This minimization of carrier exposure to the aeration in the gobbler. Carrier consumption would be in line with expectations.

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ADDITIVE CONSUMPTION

- **EPL-A Brightener**

  Still high consumption (~1750 ml/KAHr)

  Not a function of the gobbler re-generation
- **EPL-B Carrier**

  Carrier breakdown occurs at the Gobbler.

Keep the Gobbler off and bag the anodes, to minimize **oxygen** in the bath.

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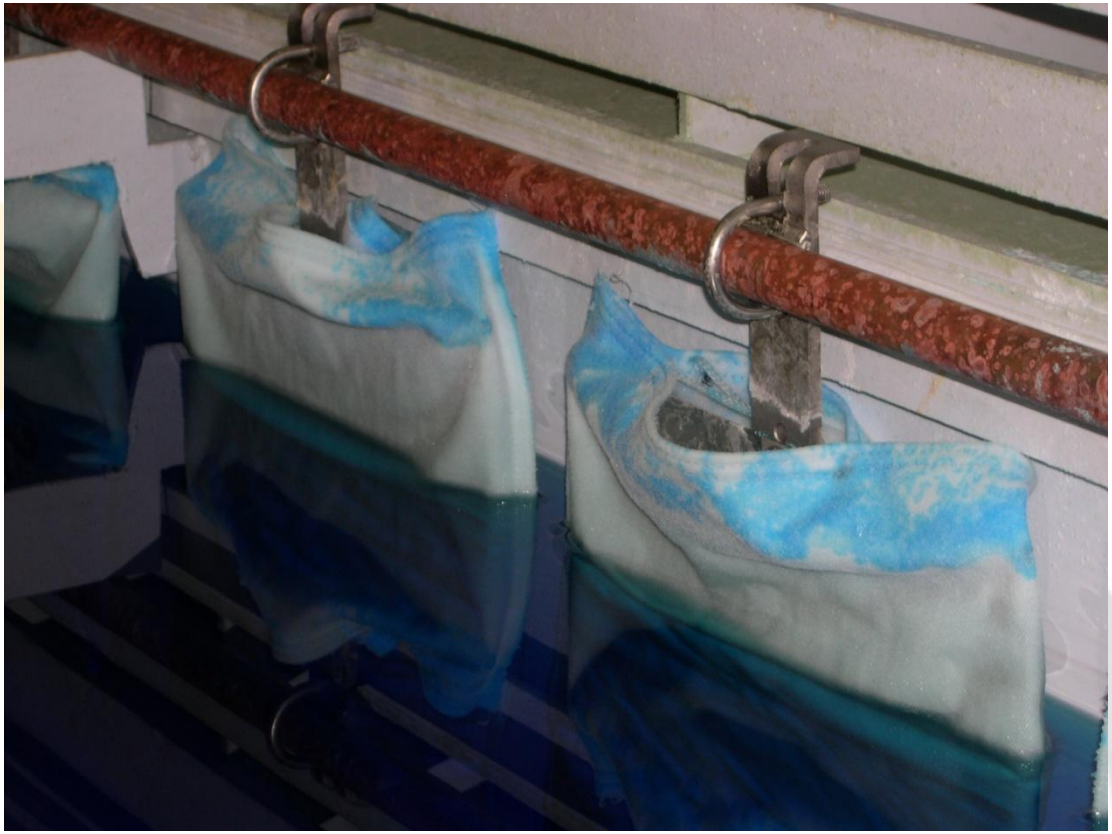
Anodes Bagged



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ADDITIVE CONSUMPTION

900 Amps, Anodes BAGGED Gobbler OFF

Time	EPL-A 0.2-0.7ml/L	EPL-A addition liters	EPL-B 10-40 ml/L
9:25am	0.65	1.5	15.0
10:45am	0.50	No Add	15.1
12:53pm	0.49	No Add	14.7
1:42pm	0.46	No Add	No Analysis
2:41pm	0.47	No Add	No Analysis
USAGE:	NORMAL		NORMAL

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ADDITIVE CONSUMPTION

- **EPL-A Brightener**

Consumption down to >500 ml/KAHr

- **EPL-B Carrier**

Expected normal consumption 750 ml/KAHr

Anodes bagged, no gobbler online

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ADDITIVE CONSUMPTION

COPPER REGENERATION

- The Gobbler is discontinued.
- A CuO delivery system is presently in use.

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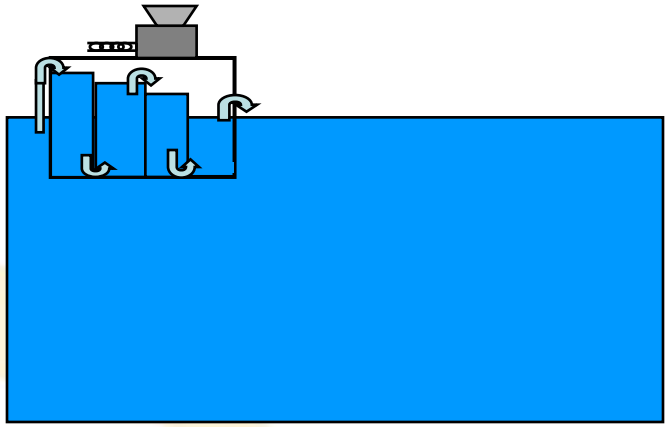
CuO Feeding System

The CuO is fed through a screw feeder.
The feeder gets its signal from the AHr accumulator.
Every 1KAHr the feeder delivers 1.526 Kg into the cascading mixer.



Chema Technology
Waukesha WI

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The CuO Dissolution System

The "DisCoP" CuO dissolution system comes complete with a controller, pump, screw feeder and mixer

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Copper Regeneration

- **CuO Regeneration**

  Maintained the $CuSO_4.5H_2O$ at 50 g/L +/- 1g/L for the last 6 months.

  Trouble free operation.

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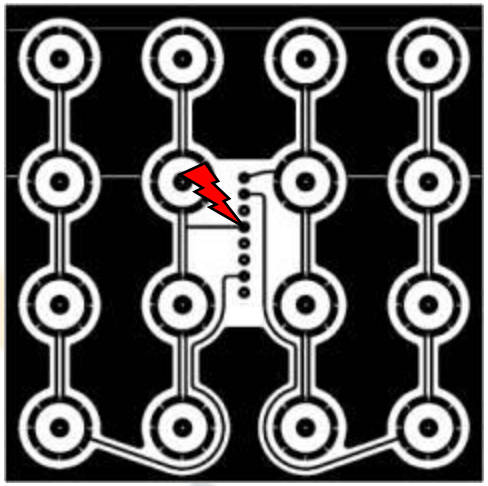
Distribution Evaluation

An 18 X 24” panel with a repeating pattern was chosen for the study.

Readings were taken using a CMI Probe.

20 readings were taken from each panel.



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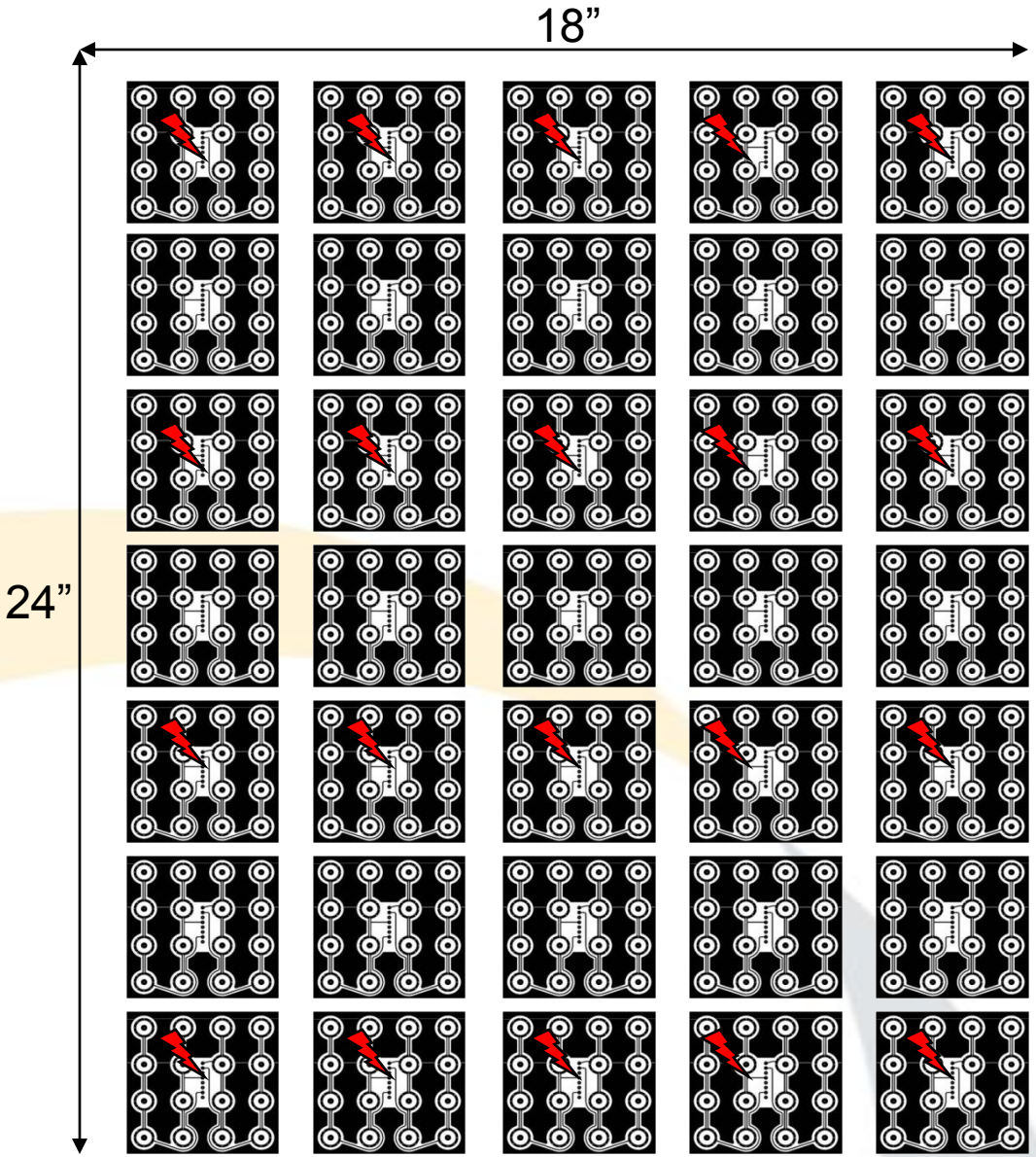
Distribution Evaluation

20 readings were taken from each of the 5 panels across the fight bar.



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Distribution Evaluation

15 ASF for 90 minutes

20 measurements were taken per panel across the 5 panels on the flight bar.

Position 1					Position 2					Position 3					Position 4					Position 5				
1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.2	1.1	1.3	1.2	1.3	1.3	1.3	1.2	1.3	1.3	1.2	1.1	1.3	1.2	1.1	1.0	1.0
1.6	1.5	1.3	1.3	1.2	1.2	1.2	1.3	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.2	1.2	1.3	1.2	1.1	1.3	1.2	1.2	1.1	1.2
1.7	1.6	1.4	1.2	1.3	1.3	1.3	1.3	1.3	1.1	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.1	1.2	1.2	1.3	1.3	1.2	1.3
2.1	1.8	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.5	1.5	1.5	1.4	1.5	1.4	1.4	1.3	1.4	1.4	1.4	1.4	1.5

The readings on the left edge and the bottom edges were high.

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Initial Readings

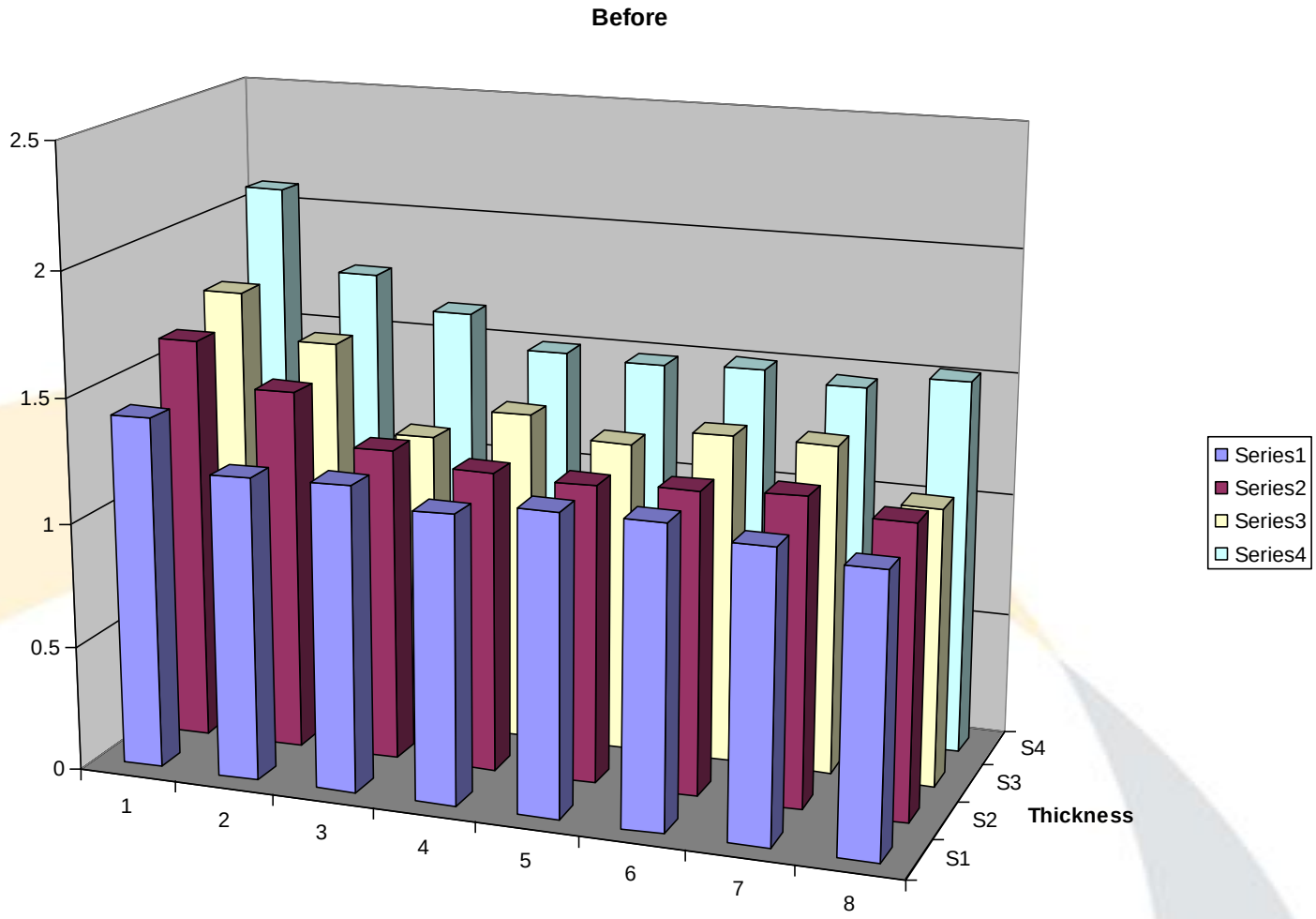
Initial readings showed that the thickness values on the bottom and the left edge of the flight bar were high.

Position 1					Position 2				
1.42	1.22	1.18	1.23	1.16	1.21	1.21	1.28	1.16	1.12
1.63	1.46	1.32	1.26	1.21	1.20	1.22	1.26	1.24	1.18
1.74	1.56	1.38	1.21	1.34	1.26	1.33	1.33	1.33	1.12
2.09	1.76	1.64	1.63	1.50	1.48	1.50	1.50	1.46	1.52

After Anode Adjustment

After anode were raised from the bottom and shifted to the left, thickness values were uniform

Position 1					Position 2				
1.17	1.11	1.10	1.15	1.12	1.23	1.24	1.18	1.17	1.11
1.23	1.15	1.16	1.11	1.16	1.14	1.15	1.18	1.19	1.16
1.25	1.22	1.19	1.17	1.19	1.19	1.20	1.22	1.22	1.14
1.30	1.19	1.19	1.20	1.18	1.23	1.31	1.29	1.32	1.34



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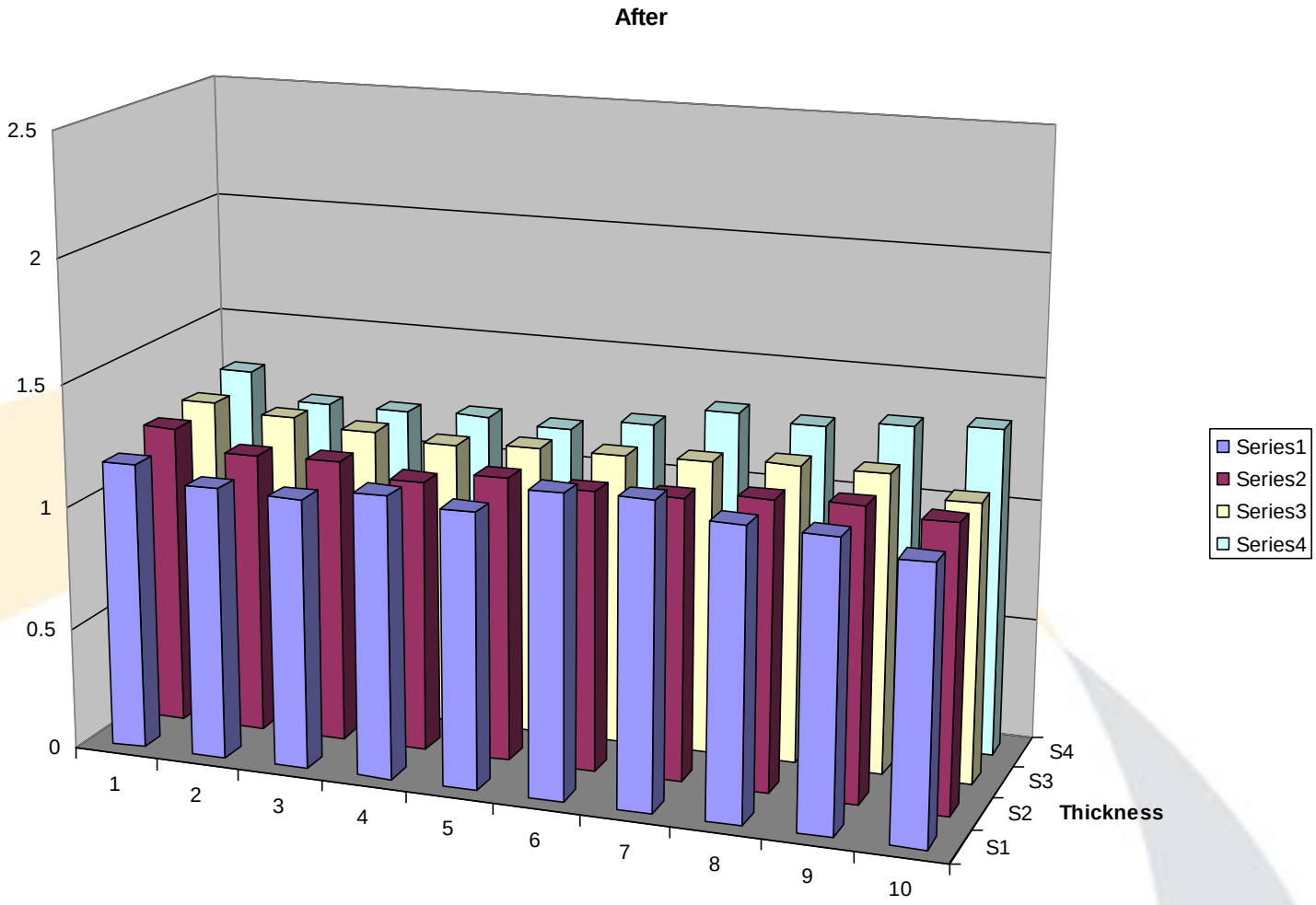
After
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
S4
S3
S2
S1
Thickness
Series1
Series2
Series3
Series4

Today
Additive Consumption

- EPL-1-4A Brightener

  Expected: 450ml/KAHr

  Actual: 600ml/KAHr

- EPL-1-B Carrier

  Expected: 750ml/KAHr

  Actual: 450ml/KAHr

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At Present
10 Months of Operation

- No change in performance
- No anode location changes
- No bags changed
- No dummy plating, always ready to plate
- First Carbon-Treat after 10 months, or 146 KAH/L of bath

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Example of Plating at Electrotek

Thru Cup EPL
Insoluble Anode

Hole size: *8 mil*

Bd Thickness: *125mil*

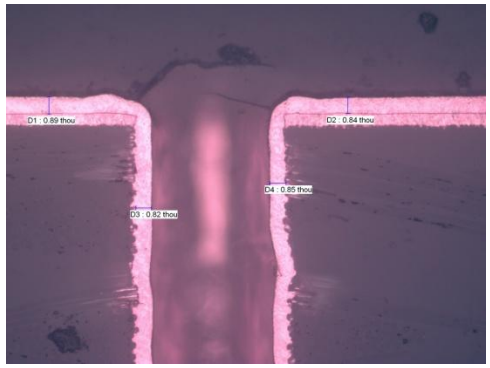
Aspect Ratio: *>1:15*

Max Surface: *0.99mil*

Min Hole : *0.88mil*

TP: **89**

TOP



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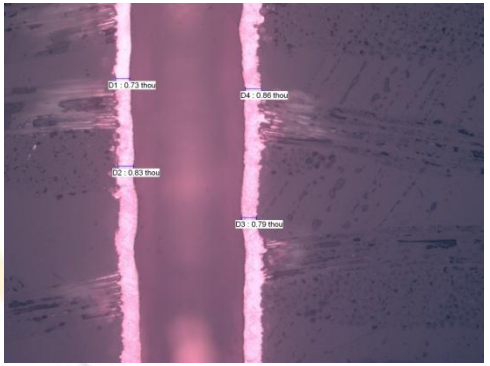
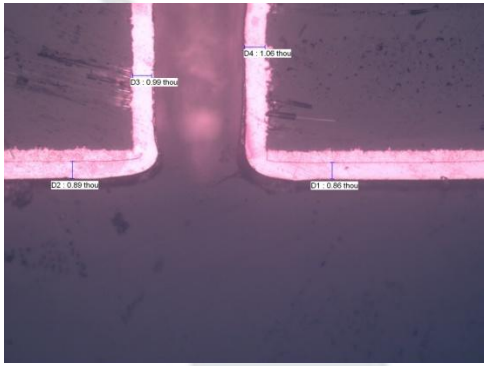


BOTTOM



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Example of Plating at Electrotek

Thru Cup EPL

Insoluble Anode

CD: *10 ASF*

Time: *120 min*

Agitation: *1 stroke/min*

EPL-A: *0.46ml/L*

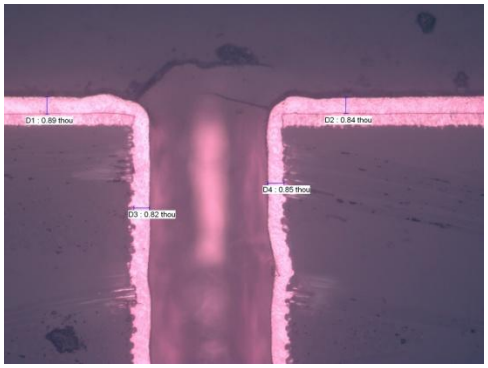
EPL-B: *13.8 ml/L*

CuSO4: *49.8 g/L*

H2SO4: *252.0 g/L*

Cl: *56 mg/L*

TOP



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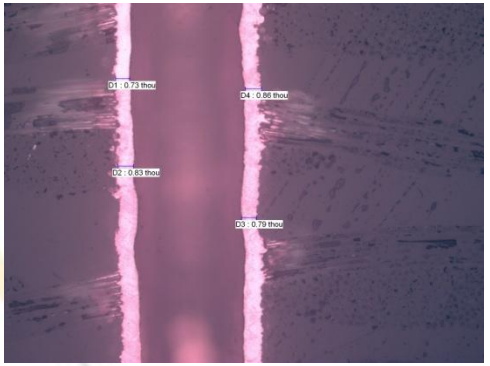

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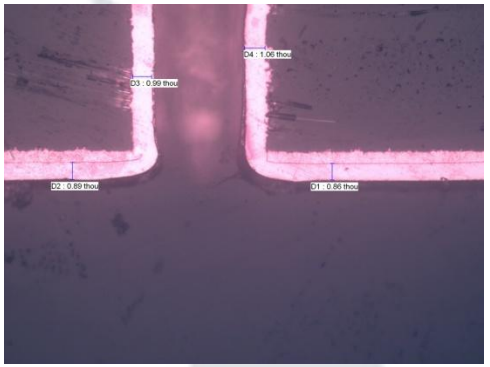

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INSOLUBLE ANODE
Electrotek

The Brightener over-consumption was controlled by bagging the anode to prevent the oxidation of the additive.

The Carrier initial high consumption may be controlled by CuO re-generation or using the Gobbler in a modified batch mode.

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INSOLUBLE ANODE
Electrotek

Insoluble anode is a success story.

- *Excellent thickness distribution*
- *No anode maintenance*
- *No dummy plating*
- *No excessive Additive consumption at the Anode.*
- *No copper waste or Cu growth*
- *C-Treat after 0.75-1.0 million AHrs ~150AH/L*

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Successful Implementation of Insoluble Anodes in Vertical Acid Copper Plating at Electrotek Corp, Oak Creek

Thank you

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